BYTE®

the small systems journal

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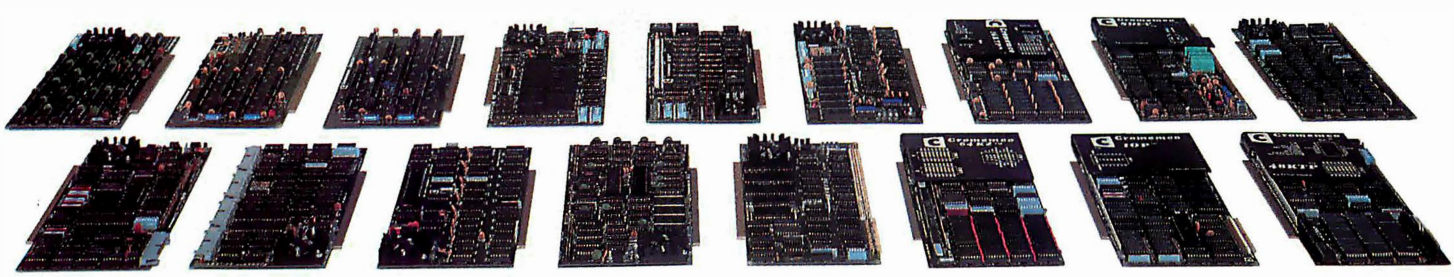


JAPANESE COMPUTERS

A new small computer that won't limit you tomorrow



New Cromemco System One shown with our high-capability terminal and printer.



Expandability

Here's a low-priced computer that won't run out of memory capacity or expandability halfway through your project.

Typically, computer usage tends to grow, requiring more capability, more memory, more storage. Without a lot of capability and expandability, your computer can be obsolete from the start.

The new System One is a real building-block machine. It has capability and expandability by the carload.

Look at these features:

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- **CRT and printer interfaces**
- **Eight S-100 card slots, allowing expansion with**
  - **— color graphics**
  - **— additional memory**
  - **— additional interfaces for telecommunications, data acquisition, etc.**
- **Small size**

GENEROUS DISK STORAGE

The 780K of disk storage in the System One Model CS-1 is much greater than what is typically available in small computers. But here, too, you have a choice since a second version, Model CS-1H, has a 5" Winchester drive that gives you **5 megabytes** of disk storage.

MULTI-USER, MULTI-TASKING CAPABILITY

Believe it or not, this new computer even offers multi-user capability when used with our advanced CROMIX* operating system option. Not only does this outstanding O/S support multiple users on this computer but does so with powerful features like multiple directories, file protection and record level lock. CROMIX lets you run multiple jobs as well.

In addition to our highly-acclaimed CROMIX, there is our CDOS*. This is an enhanced CP/M† type system designed for single-user applications. CP/M and a wealth of CP/M-compatible software are also available for the new System One through third-party vendors.

COLOR GRAPHICS/WORD PROCESSING

This small computer even gives you the option of outstanding high-resolution color graphics with our Model SDI interface and two-port RAM cards.

Then there's our tremendously wide range of Cromemco software including packages for word processing, business, and much more, all usable with the new System One.

ANTI-OBSOLESCENCE/LOW-PRICED

As you can see, the new One offers you a lot of performance. It's obviously designed with anti-obsolescence in mind.

What's more, it's priced at only $3,995. That's considerably less than many machines with much less capability. And it's not that much more than many machines that have little or nothing in the way of expandability.

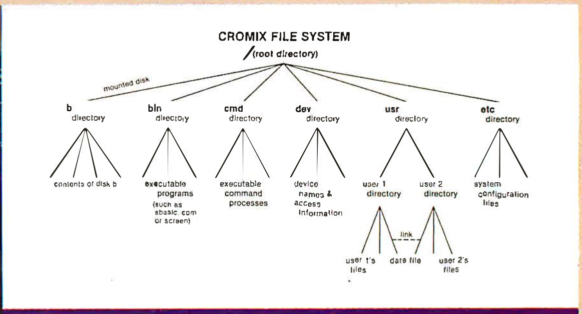
Physically, the One is small — 7" high. And it's all-metal in construction. It's only 14⅛" wide, ideal for desk top use. A rack mount option is also available.

CONTACT YOUR REP NOW

Get all the details on this important building-block computer. Get in touch with your Cromemco rep now. He'll show you how the new System One can grow with your task.

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CROMIX*— Cromemco's outstanding UNIX†–like operating system

CROMIX is just the kind of major development you've come to expect from Cromemco. After all, we're already well-known for the most respected software in the microcomputer field.

And now we've come up with the industry's first UNIX-lookalike for microcomputers. It's a tried and proven operating system. It's available on both 5" and 8" diskettes for Cromemco systems with 128K or more of memory.

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- Completely compatible file, device, and interprocess I/O
- Extensive subsystem support

FILE SYSTEM

One of the important features of our CROMIX is its file system comprised of hierarchical directories. It's a tree structure of three types of files: data files, directories, and device files. File, device, and interprocess I/O are compatible among these file types (input and output may be redirected interchangeably from and to any source or destination).

The tree structure allows different directories to be maintained for different users or functions with no chance of conflict.

PROTECTED FILES

Because of the hierarchical structure of the file system, CROMIX maintains separate ownership of every file and directory. All files can thus be protected from access by other users of the system. In fact, each file is protected by **four separate access privileges** in each of the three user categories.

TREMENDOUS ADDRESS SPACE, FAST ACCESS

The flexible file system and generalized disk structure of CROMIX give a disk address space in excess of one gigabyte per volume — file size is limited only by available disk capacity.

Speed of access to disk files has also been optimized. Average access speeds far surpass any yet implemented on microcomputers.

'C' COMPILER AVAILABLE, TOO

Cromemco offers a wide range of languages that operate under CROMIX. These include a high-level command process language and extensive subsystem support such as COBOL, FORTRAN IV, RATFOR, LISP, and 32K and 16K BASICs.

There is even our highly-acclaimed 'C' compiler which allows a programmer fingertip access to CROMIX system calls.

THE STANDARD O-S FOR THE FUTURE

The power and breadth of its features make CROMIX the standard for the next generation of microcomputer operating systems.

And yet it is available for a surprisingly low $595.

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In The Queue

BYTE Volume 7, Number 5 May 1982

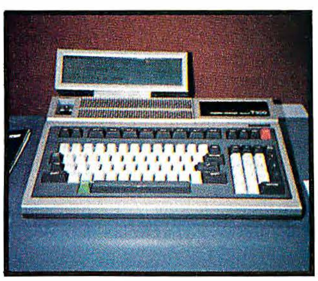
Features

Reviews

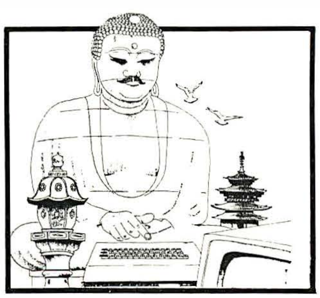
Nucleus



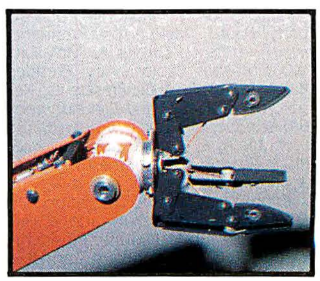
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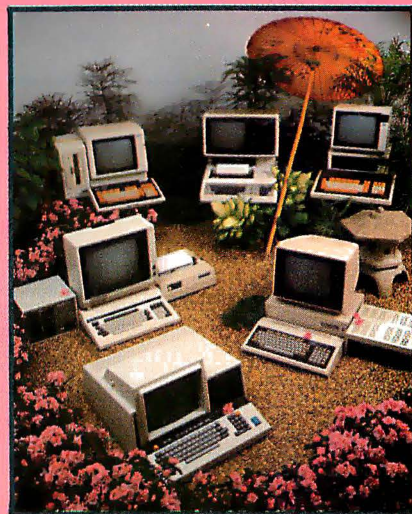
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In This Issue

The Japanese entered the American personal computer market in earnest this year, and as one might expect, their products come standard with a host of "extras" at a price competitive with current American designs. This month we look closely at several Japanese personal computers—some that are already on the market, some that are on the horizon, and some that may never be sold in this country. Six machines, from Hitachi, BMC (Oki), Fujitsu, Canon, Systems Formulate, and NEC, are featured on the cover (photographed by Paul Avis; Pauline Elkin, stylist). For reviews of these computers see "Six Personal Computers from Japan" by Christopher P. Kocher and Michael Keith. Phil Lemmons discusses the companies responsible for these computers in "The Machines Behind the Machines." For a brief introduction to three new Japanese computers that were shown at the recent Consumer Electronics Show in Las Vegas see "Japan Update" by Mark Haas.

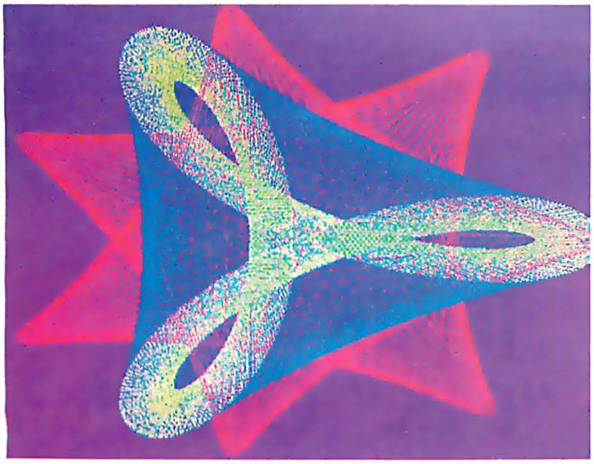
Steve Ciarcia tells you how you can build a real-time clock simply and inexpensively. Steve Leibson continues the Input/Output Primer with Part 4, in which he describes BCD and serial interfaces. Part 9 of the Atari Tutorial is on colors, and William Barden Jr. talks about ports of entry for the Color Computer and Model III.

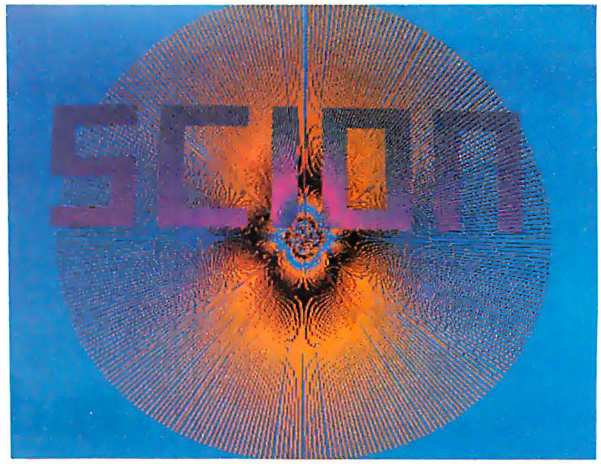
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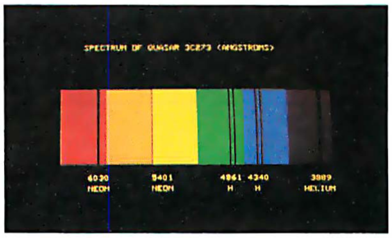
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BYTE, Product Review

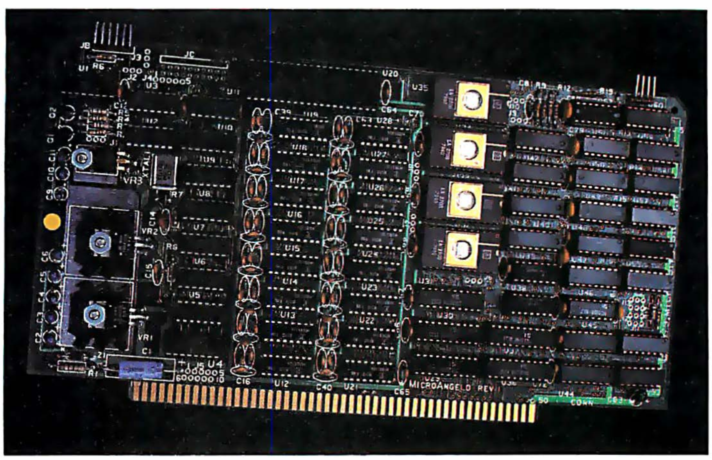


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Editorial

Japan and the "64K" Question

by Chris Morgan, Editor in Chief

Last May, Senior Editor Gregg Williams and I went to Tokyo to prepare for this special issue featuring the new Japanese personal computers. "Will the Japanese take over?" we asked ourselves during our ten-day whirlwind tour of major Japanese electronics firms. That was the 64K question. The answer is "There *is* no answer."

One can draw parallels to other consumer markets in which the Japanese have become dominant, but those comparisons would be risky. For one, U.S. companies offered no real competition to the Japanese when the latter swept in to blitz the car, camera, and audio markets. But the situation is fundamentally different in the computer field. The vast majority of technical computer innovations have come from American research-and-development labs—till today, at least. But now the Japanese are aggressively entering the R&D field. Therein lies the danger (or the opportunity, depending on your point of view).

The question of whether the Japanese will take over or not is, in a sense, moot. By one definition they already have. Lift the lid on almost any personal computer and you'll see scores of Japanese-made components: resistors, capacitors, and ICs (especially memories, a field where the Japanese dominate the world market). Often a majority of the components are made in Japan. Yet in another sense the Japanese must fight an uphill battle against the creativity of American computer companies.

The other big "if" in the picture is the U.S. government's position on Japanese imports in general. The Japanese are all too aware that a major change in import duties or quotas could quickly cut them off from the world's most lucrative consumer-electronics and computer market.

What will their strategy be? I see a two-pronged approach: (1) form joint ventures with American companies so the Japanese will have access to the U.S.'s vaunted software experience, and (2) complete the development of the recently announced "Japanese master plan for a fifth-generation computer system" with a massive R&D push. I'll describe both approaches in detail. First, the joint-venture strategy.

Japanese-American Joint Ventures

The Japanese are weakest in software development; their track record has been uneven. They've developed some of the best video-game software in the business (e.g., Space Invaders and Pac-Man), but their business software has been virtually nonexistent. One reason for this is the radically different way the Japanese conduct business, a direct function, in turn, of the complexity of written Japanese. The Japanese use three different character sets containing a myriad of symbols. A conventionally designed Japanese typewriter would be almost a contradiction in terms. To my knowledge there are no typewriters

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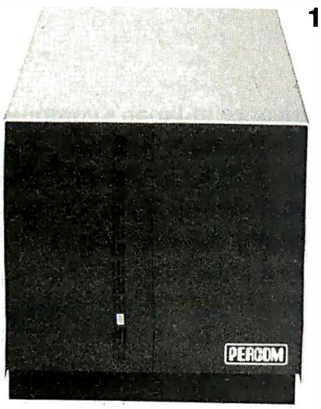
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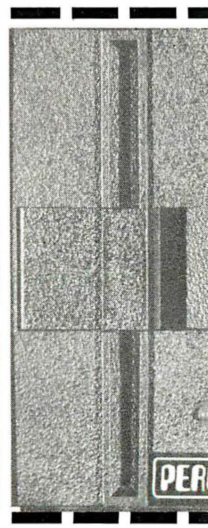
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that can type Japanese characters. (Significant progress is being made, however, in the display of Japanese characters on video screens. At last year's Tokyo Microcomputer Show, several computer terminals were shown for the first time displaying all three Japanese character sets: kanji, katakana, and hiragana.) Japanese secretaries write all business correspondence—what there is of it—in longhand because most negotiations are conducted verbally. As a result, the Japanese lack an intuitive understanding of American office procedures and are hampered in their ability to design good word-processing software.

To remedy this situation, many Japanese computer companies are obtaining licenses from U.S. companies to use software such as CP/M, Microsoft BASIC, and Visicalc on Japanese computers, and they are forming joint ventures with American companies, such as the Fujitsu/TRW connection. This type of alliance helps cloud the issue of import restrictions, because the U.S. companies could rightly claim that actions against a Japanese partner would hurt the American partner too. Japanese companies are also building, or planning to build, production plants in America. Japanese electronics companies are sometimes more adventuresome than their American counterparts. In the videodisc field (which we'll be covering in detail next month), despite IBM's and MCA's withdrawal from the laserdisc market, Pioneer is planning to build an American videodisc production plant. Pioneer deserves high praise for backing the best videodisc format and not letting it die. It's unfortunate that RCA and Sears are continuing to promote the inferior Selectavision system.

The "Master Plan"

Of potentially greatest significance in Japan's computer fortunes is the ten-year plan for national computer policy announced last fall by the Japanese Information Processing Development Center (JIPDEC), whereby Japanese computer companies would jointly develop a grandiose fifth-generation computer system on several different levels, relying on sophisticated artificial-intelligence research into natural languages and graphics. (See Tom Manuel's article, "Japan Maps Computer Domination," page 140.) This may sound like a major threat, but as Tod Zipnick says (page 118), in many cases Japanese computers are designed for the Japanese market. One of the biggest technological problems the Japanese face today is that their written language is virtually unusable for fostering computer literacy. (All the Japanese software we saw was written mostly in BASIC with Japanese REM statements. The REM statements were written in a phonetic, Roman form of kanji that the Japanese use with some reluctance because it is considered aesthetically inferior to true kanji. Quite simply, there is no practical alternative if the Japanese wish to do any meaningful programming. The fact is that every high-level language

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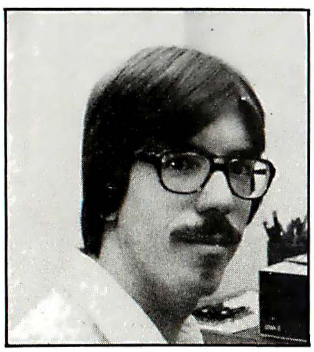
presently in existence uses some form of the English-based ASCII character set.) And the Japanese (like the Chinese, who face a similar problem) must become as computer-literate as the rest of the world to survive in the coming computer age. Their preoccupation with overcoming the computer-language barrier will necessarily temper their aggressive ways for a while. Nonetheless, I have a great deal of respect for their ability to get up to speed quickly.

I welcome the Japanese into the "international computer sweepstakes." Only when we begin to think on a more global than national scale will we see that the so-called "Japanese threat" is really more of an "international promise."

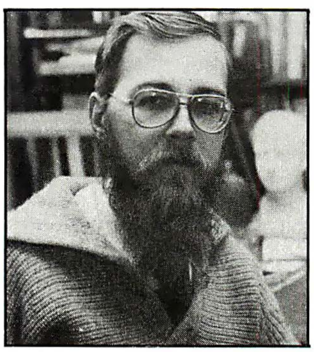
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A Note About Our Hardware Reviewers

This month we review six Japanese computers in "Six Personal Computers from Japan" (page 60) cowritten by Michael Keith and Christopher Kocher. Both men work in advanced computer science research in the southern New Jersey area and wrote the NEC PC-8001 review that appeared in the January 1981 BYTE (page 72). Producing these six comprehensive reviews was a major undertaking, and we thought BYTE readers would enjoy learning a little bit about their backgrounds.



Michael Keith



Chris Kocher

Michael Keith is 26 years old and has a BS degree in electrical engineering from the New Jersey Institute of Technology and an MS in electrical engineering from Stanford University. He owns an Apple II computer. Among other things, he uses it in his spare time to manage the finances of his church. His other pursuits include playing the piano, reading, and juggling.

Thirty-four-year-old Chris Kocher has a BA in chemistry and an MS in systems engineering, both from the University of Pennsylvania. He is, in his own words, "slowly making my way toward a PhD in systems engineering." His hobbies include collecting books (over 2000 so far) and cross-country skiing.■

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Unequaled Hardware Support

The CRT version directly supports over 35 terminals (including ANSI standard) in its installation menu and utilizes 'smart' terminal features such as line insert/delete, reverse scroll, status line and reverse video. Function keys on terminals like the Televideo 920/950, Heath H19, and IBM 3101 are all supported. The memory mapped version is extremely flexible, supports bank select such as on the SSM VB3 and screen sizes up to 70 X 200.

Sophisticated Full Screen Editing

VEDIT gives you true 'what you see is what you get' full screen editing with an extensive set of features for creating and editing standard text files of up to one diskette in length. Very large files are effortlessly handled by VEDIT's ability to edit up to 47K of a file entirely in memory without performing any slow and annoying disk accessing. And you can handle multiple files, insert a specified line range of another file anywhere in the text and even change diskettes.

User Oriented Features

You get the features you expect, like searching, a scratchpad buffer for moving and rearranging sections of text, complete file handling on multiple drives and flexible macros. For ease of use VEDIT has features you won't find elsewhere, like automatic indenting for use with structured languages such as Pascal and PL/I. You are less likely to make a mistake with VEDIT, but if you do, one key will 'Undo' the changes you just made to a screen line. And if you run out of disk space with VEDIT, you can easily recover by deleting old files or even inserting another diskette. It is therefore no surprise that VEDIT is the industry standard for program development editing.

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VEDIT is suitable for simple stand-alone word processing, or it may be used in conjunction with a text processor. Its features include word wrap, adjustable left margin, reformatting of paragraphs, word oriented cursor movement and deleting, and imbedding of printer control characters. VEDIT can print any portion of your file and display the cursor's line and column positions.

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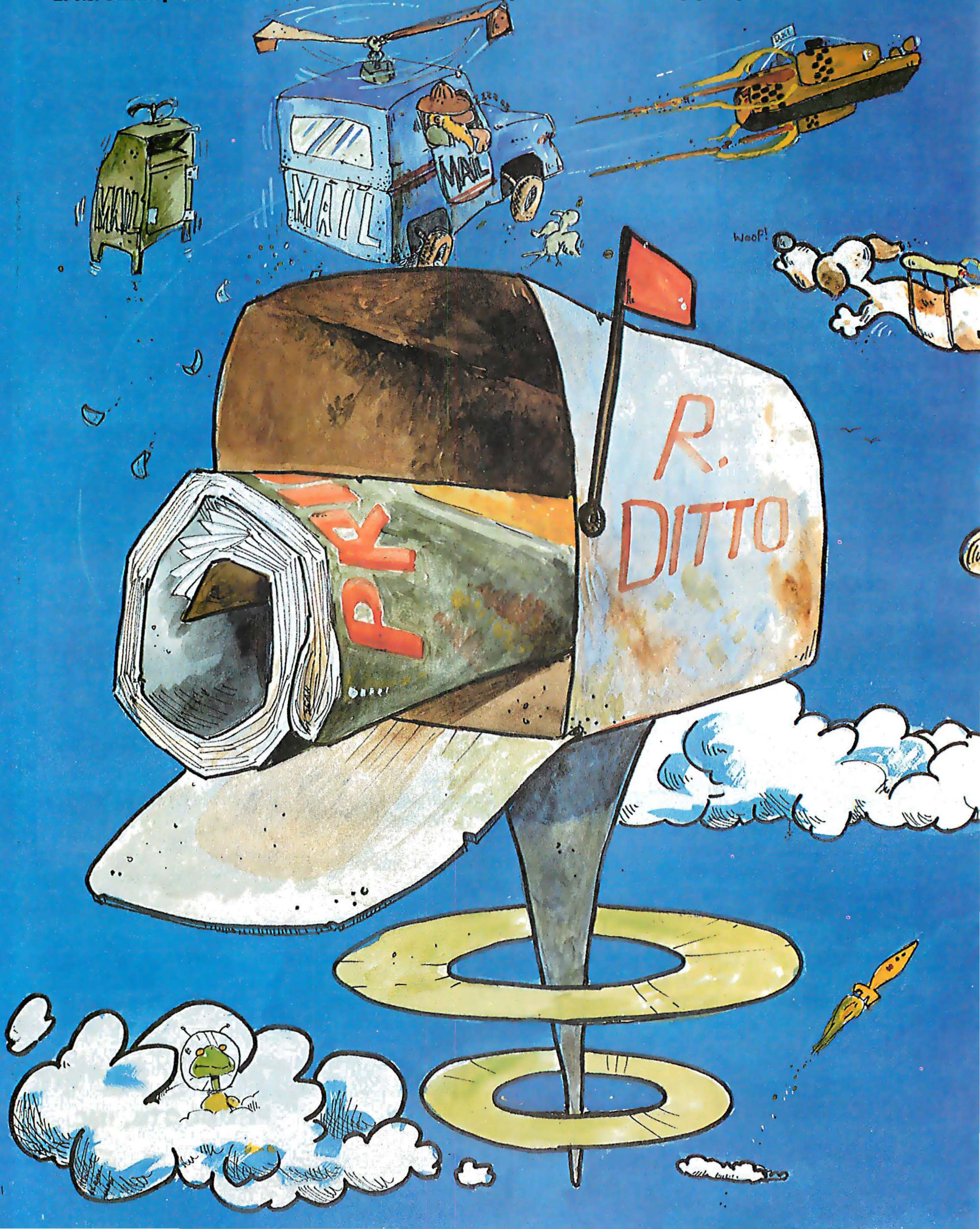
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Letters

IBM's Personal Computer

I am in love! After spending considerable time at the local IBM Product Center and reading many highly favorable articles on the IBM Personal Computer, I have concluded that it is the best personal computer on the market today.

I especially enjoyed Gregg Williams's "A Closer Look at the IBM Personal Computer" (January 1982 BYTE, page 36). This was the most complete and detailed article I have seen on the Personal Computer. However, I am confused about one point: does the BIOS (basic input/output system) reside in ROM (read-only memory) or in the DOS? From other sources, I have heard that it occupies 6K bytes of ROM, along with BASIC and the power-on self-test software; Mr. Williams contends that it is in the DOS. Who's right?

Thank you for a terrific article in a terrific magazine!

Arthur A. Glecker
2726 Saint Paul St.
Baltimore, MD 21218

In a long article, pieces of information do not always get grouped in the best possible way. Although the section on the IBM BIOS does not say that the BIOS is in ROM, the last line of table 6 (page 54) does give this information. Thanks for your interest in my article. . . . **G. W.**

I enjoyed "A Closer Look at the IBM Personal Computer." It was the first review I've read that contained nontrivial information. I learned things I didn't know even though I've read most of the manuals and have played with the computer to some extent.

On the negative side, I think your benchmarks were not quite fair to the IBM Personal Computer BASIC. Unlike most other BASICs, IBM's BASIC allows the use of integer variables in FOR statements. Since most FOR loops are over integers anyway, it certainly makes sense to use an integer variable index if it is available. In the benchmarks this could be accomplished by changing the Is to I%s or by using DEFINT I to declare I as an integer variable. If you try it, I think you'll find that it knocks 2+ seconds off each of the IBM PC times.

Jim Mehl
POB 632
Los Gatos, CA 95030

Thank you for your kind words about my article on the IBM Personal Computer. However, I must reiterate a point that seems to be forgotten by many BYTE readers: that a benchmark gains its validity by executing, as much as is possible, the same program on different machines. Integer variables are nothing new; several other Microsoft BASICs have integer variables (e.g., Apple II Applesoft and Radio Shack's TRS-80 Model III BASIC). When the same program coded with integer variables is run, the relative rankings of the machines should be almost exactly the same—but then, that's another benchmark, isn't it? And since we can't run every possible program on a computer, we run a set of benchmark programs that we have carefully chosen to be representative. We did not use a full set of benchmarks in the IBM article due to time constraints; however, a full set of BASIC benchmarks was used to test the six Japanese computers reviewed in this issue (see page 60). . . . **G. W.**

Gregg Williams's "A Closer Look at the IBM Personal Computer" was highly informative. It is a worthy successor to Phil Lemmons's article, "The IBM Personal Computer: First Impressions" (October 1981 BYTE, page 26). The comparison between IBM medium resolution (320 pixels per row) and IBM high resolution (640 pixels per row), which is discussed on page 39 and pictured in photo 6, may be unfair. The performance in high-resolution mode is probably limited by the resolution of the red-green-blue (RGB) monitor that was used. The RGB color monitor shown in photo 1 appears to be an Amdek Color II, which is advertised to resolve up to 560 pixels per row—80 less than the high-resolution mode of the IBM Color/Graphics Monitor Adapter.

Incidentally, Amdek is now accepting orders for a $10 adapter that enables its RGB monitor to use the intensity bit carried on pin 6 of the IBM Color/Graphics Monitor Adapter, and thereby to generate 16 colors.

Gary G. Price, Assistant Professor
Department of Curriculum and Instruction
University of Wisconsin—Madison
Teacher Education Building
225 North Mills St.
Madison, WI 53706

Though the monitor we used was not supplied by Amdek, it is functionally identical. Both are produced by Hitachi and are RGB high-resolution monitors. When ordering the intensity bit adapter from Amdek, ask for the 16-Color Modification. Future models of the Amdek Color II will include built-in 16-color capability. Amdek is located at 2420 E. Oakton St., Suite E, Arlington Heights, IL 60005 (312) 364-1180. . . . **M. H.**

Too Much Praise for IBM?

BYTE has defined a new era in personal computing—in terms of IBM. No customer experience taken into account, no long-term usage needed to evaluate—the IBM Personal Computer is arriving, therefore nothing else need be said. Let us all dispose of our several hundred thousand IBM imitations, which just coincidentally predate the Personal Computer by some years.

What has IBM learned from its own and others' experience? First and foremost (to quote Chris Morgan's editorial, "Of IBM, Operating Systems, and Rosetta Stones," January 1982 BYTE), "the keyboard alone is one of the best I've seen, though I wish the shift keys were more conventionally placed. (Oh, well.)" Is "Oh, well" the only comment appropriate to the "best keyboard" designed by a company that has produced what may purport to be the standard of office typewriter excellence? BYTE simply passes off a conscious corporate stupidity with an "oh well." Justify it to the typist who uses a typewriter alternately with the new "oh well" standard and hits the wrong keys consistently on both.

How many other facets of this machine have been glossed over in the same manner but without accompanying comment? Are we seeing the new BYTE objectivity? A 16-bit chip operating in 8-bit mode is

justifiable because IBM is running at 4.77 MHz (let's have another resounding "oh well" for IBM's high speed).

The reason for all this is to point out, to some of your less sophisticated readers, that for each flaw (if I may use such a four-letter word in conjunction with IBM) there appears to be a BYTE rationale to justify it.

I don't remember, in the history of BYTE, any other company or products being accorded such accolades for a product yet unproven in the field with software, other hardware, and peripherals.

McGraw-Hill owns BYTE. Does IBM own McGraw-Hill?

Jack Kahn
6013 Summerhill Rd.
Camp Springs, MD 20748

Oh, well. I'm afraid Mr. Kahn misinterpreted my editorial, or failed to read the January BYTE closely enough. If he had, he would have realized that we discussed the shortcomings of the IBM machine in Gregg Williams's review on pages 60 and 61, including comments about the machine's speed. To imply that we have been less than forthright in evaluating the IBM Personal Computer is patently unfair. In fact, next month's BYTE contains some fairly strong criticism by Jerry Pournelle about shift-key placement on the IBM, and last month we printed an article about the good and bad human-factors design points of the machine ("A Human-Factors Case Study Based on the IBM Personal Computer" by Robert G. Cooper Jr., Paul Thain Marston, John Durrett, and Theron Stimmel, page 56). I'm distressed by Mr. Kahn's implication that we are somehow in cahoots with IBM, or that we are withholding our true opinions. We simply stated what we thought about the machine: that it has a very good overall design—period. . . . C. M.

Unwarranted Warranties

I read with interest the interchange of letters between Intertec's Manager of Public Relations and one of the firm's customers (see "Open Letter to Potential Superbrain Buyers," January 1982 BYTE, page 18).

Significantly, Intertec made no case to justify its warranty policies other than to refer to "rules," that is, their Master Agreement. As an independent consultant to the industry for product-support operations, I advise my clients to accept full responsibility for field failures arising out of component failures following delivery. Realistically, there is no such thing as a shelf life for electronic devices; these devices are not loaves of bread.

This ploy is peculiar to the computer and computer peripheral industry. It is not practiced by responsible and knowledgeable manufacturers of electronic devices in other areas of the industry. It appears to be nothing more or less than a ploy to avoid warranty responsibilities. There is simply no justification for penalizing the ultimate consumer because a product did not move off the shelf within some arbitrary time period established by the manufacturer. Business can be bad—the dealer simply may be unable to move his merchandise as promptly as even he would wish.

Certainly, warranty policies of this nature suggest a lack of confidence on the part of the manufacturer in the reliability of its product over the short haul.

Perhaps if Intertec and other companies employing this practice would establish

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- CC-132 offers 2 ports
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- WW-068: $75 • WW-069: $55
- WW-068 wire wrap card (13" x 4.2")
- WW-069 extender
- Get both for $95

*Our customers include: IBM, TRW, Bell Labs, Visicorp, Softech Microsystems Inc., Information Unlimited Software, Context Management, Network Consulting Inc., etc.

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aggressive Customer Relations departments concerned with the care of customers, there would be no need of Public Relations departments in their organizations. Undoubtedly, they would experience an increase in sales plus improved relations with their dealers.

If the Federal Trade Commission ever took the time to examine this failure to extend warranty coverage to the ultimate consumer, I suspect a "cease and desist" order would be forthcoming.

I suggest that Intertec clean up its act and provide a reasonable level of protection to the guy at the end of the pipeline. He deserves nothing less.

R. C. Redpath
250 Ramblewood Parkway
Mount Laurel, NJ 08054

The letter to the editor, in the January 1982 BYTE, from James Ford of Paoluccio Willis Nau Associates regarding the purchase of several Superbrains and a subsequent misunderstanding between Mr. Ford and the dealer he purchased the equipment from points out an industry-wide problem.

Certainly, one should attempt to purchase equipment at the best possible price; however, it's important to remember that the sale is only the beginning of the relationship between the dealer and the customer. From time to time, equipment does malfunction and must be repaired; advice about communications, protocol, and software is sometimes called for.

Here at Compudial/Tristar, we give a guarantee from the date of purchase on Superbrains and other Intertec equipment and stand behind the product with knowledge of its capabilities and limitations. This is not meant to be a self-congratulatory statement; rather, it is to point out to our dealers and potential customers that, just as not all Superbrains are perfect when they come off the production line, neither are all dealers.

Simply stated, when one is purchasing any data-processing equipment, one should look for an established, knowledgeable, and reputable source that is capable of servicing the equipment.

Daniel F. Brown, President
Compudial Inc.
2 Keystone Ave.
Cherry Hill, NJ 08003

More on Intertec from the Federal Trade Commission

I read with interest the correspondence relating to the warranty on Intertec's Superbrain computer. Mr. Ford, the computer purchaser, assumed that even if the product was "inoperable when the cartons were first opened [he] would have had to pay repair charges." Intertec does not deny this interpretation of its warranty. Rather, it claims that the "warranty offers [its] customers excellent coverage. . . ." Fortunately for purchasers, Mr. Ford's idea of who has to pay may be as incorrect as Intertec's reply is disingenuous.

The law does not require that merchandise be sold with a *written* warranty. However, whether or not the manufacturer or dealer includes a written warranty, the law of 49 states (under the Uniform Commercial Code) usually implies certain warranties. For example, there is usually an implied warranty of merchantability: the goods must be fit for the general purposes appropriate to that type of goods. This implied warranty applies at the time of sale regardless of whether the manufacturer's or dealer's warranty has expired. Further, delivery of a defective item may be a total failure of consideration, or breach of contract, by the seller. I suggest that a purchaser of a defective product consult a private attorney if the seller refuses to repair or replace it. Note that this doesn't apply to products sold "as is."

Incidentally, the Federal Trade Commission enforces a law called the Magnuson-Moss Warranty Act. This law sets standards for disclosing the terms of written warranties on consumer (personal) products. Had Mr. Ford purchased a *home* microcomputer, the company's warranty would have had to state: "This warranty gives you specific legal rights, and you may also have other rights which vary from state to state."

Randall H. Brook
Assistant Regional Director
Federal Trade Commission
Seattle Regional Office
2840 Federal Building
915 Second Ave.
Seattle, WA 98174

More on Warranties

Isn't it time that our industry grew up? I just resisted purchasing an expensive piece of computer software for which the warranty reads in part:

> All . . . computer programs are distributed on an "as is" basis with-

> out warranty of any kind. The entire risk as to the quality and performance of such programs is with the purchaser. Should the programs prove defective . . . the purchaser and not the manufacturer . . . assumes the entire cost of all necessary servicing or repair. (The company) shall have no liability or responsibility to a purchaser. . . .

This is not mere legal jargon. It's the embodiment of a business philosophy which seriously harms all of us. It encourages sloppy work and inadequate testing, and it increases the potential for dishonesty. Is it any wonder that so many businessmen are turned off by computers?

To software companies I say: Accept responsibility for your products. Get the bugs out *before* you sell them. Don't try to sell a program debugged by your customers as a "revised" or improved product at additional cost.

To software consumers I say: If possible, avoid products for which there is no warranty. Don't buy on faith. Complain loudly to software companies which provide no warranty.

Of BYTE I ask: Speak out on the importance of product and software warranties. Help your readers by reporting on the warranty provided in your product and software reviews, perhaps in your "At a Glance" boxes. Praise the responsible firms that produce quality products and help to expose the ones with a reputation for bugs.

John Navas II
490 Mariners Island Blvd., #108
San Mateo, CA 94404

Note Pad for the Handicapped

I think that Howard Batie's article "Handi-Writer, A Video Note Pad for the Physically Handicapped" (December 1981 BYTE, page 474) described the most valuable and original application of a microcomputer that I have seen.

I have worked extensively with the handicapped, including many cerebral palsy victims, and I agree with Mr. Batie's estimate that these people are not generally intellectually deficient. Many feel that they are emotionally unstable, but I have never seen any evidence of instability that was not explainable, to me, by their severe frustration. What a boon it would be for such an imprisoned mind to finally be able to communicate!

I am sure it would not be difficult to add another button to the control panel so that data could be output to a printer, or this could be done by intervention of a companion, when the user is satisfied with the text in the buffer.

Imagine—correspondence and creative writing for those who previously had no means of expression.

Ralph Nottingham
1619 SE 3rd Court
Deerfield Beach, FL 33441

Software Copyright Kit

I have received an overwhelming number of inquiries concerning the booklet "The Copyright Kit—How to Copyright Your Computer Software," which was mentioned in a letter published in the October 1981 BYTE (see "Legal Arguments," page 10). You must have an incredible readership! Letters and telephone calls poured in from all over the country, as well as from England and Italy.

Please inform your readers that the Copyright Kit is available for $12.95 (plus $2 postage and handling) from B. T. Enterprises, 171 Hawkins Rd., Centereach, NY 11720, and from National Attorneys' Publications Inc., POB 150, East Setauket, NY 11733.

Noel D. Adler
POB 150
East Setauket, NY 11733

Apathetic Advertisers

As one of the millions whose relationship with computers has been an adversary one, my interest in them was zilch until I read *The World Challenge* by Jean-Jacques Servan-Schreiber (Simon and Schuster 1981), a book in which the role of computers in the world of tomorrow is rather graphically delineated. The mention of BYTE in the same book led to my subscribing to your publication.

Although I find much of the material in BYTE less than comprehensible, I'm slowly learning about computers and the many possibilities they offer. I've already decided to buy a home computer; unfortunately, many of your advertisers do little to facilitate the process of evaluating their products and services.

For example, I wrote to Apple for brochures and specifications on its various models, accessories, software, etc. In return, the company sent a booklet outlining the development of its Apple

III—but none of the more useful materials I'd requested. I've written Atari twice and telephoned once; many weeks later, Atari has not yet deigned to reply. Of the half-dozen or so computer stores I've written for price lists and information, only one has bothered to reply.

I gather, from the heft of your publication and its numerous advertisements, that there is a rather substantial industry centered around home computers and allied products and services. But I also get the impression nobody's particularly interested in showing any initiative to assist a would-be purchaser in obtaining information that would be helpful in making a reasonably rational buying decision.

H. B. Brandon
1204 Park Lane
Clarksdale, MS 38614

More on a Structured 6809 Assembly Language

Greg Walker's interesting article, "Toward a Structured 6809 Assembly Language" (November 1981 BYTE, page 370), will be helpful to many people who, for one reason or another, are forced to write in assembly language.

Use of higher-level language control structures in assembly language goes back a long way. In general, there have been two approaches.

The first approach is to write a special assembler which includes high-level control structures as part of the language. The earliest descriptions of this approach with which I'm familiar appeared in Niklaus Wirth's "PL360, A Programmable Language for the 360 Computers" (*Journal of the Association for Computing Machinery*, 15:1 (1968), pp. 37-74) for a large machine, and Bell and Wichman's "An ALGOL-like Assembly Language for a Small Computer" (*Software—Practice and Experience*, 1 (1971), pp. 61-72).

This approach can produce comprehensive error messages and more efficient generated code because long/short branches, etc., can be optimized.

The second approach is to implement the control structures via the manufacturer's standard macro-assembler, as in Walker's 6809 macros. The first description of this approach that I know of is M. M. Kessler's *CONCEPT* Report 14, *Implementation of Macros to Permit Structured Programming in OS/360* (IBM Corporation, Gaithersburg, MD 20760, 1970). The macro approach has the advantage of being piggy-backed on the standard assembler, thus greatly reducing the amount of documentation and programming needed to support it. Also, the macros can be examined easily and altered, if needed, by the user.

When our laboratory implemented Pascal-like control structures for the PDP-11 Macro-11 Assembler several years ago, we discovered that assembler programs with high-level control structures (IF . . . THEN, DO . . . WHILE, REPEAT . . . UNTIL and CASE) were much easier to write, debug, and maintain than the FORTRAN programs we wrote for the PDP-11 (FORTRAN was the only "high-level" language available to us on the PDP-11 at that time).

Scott Herman-Giddens
Department of Computer Science
Duke University
Durham, NC 27706 ■

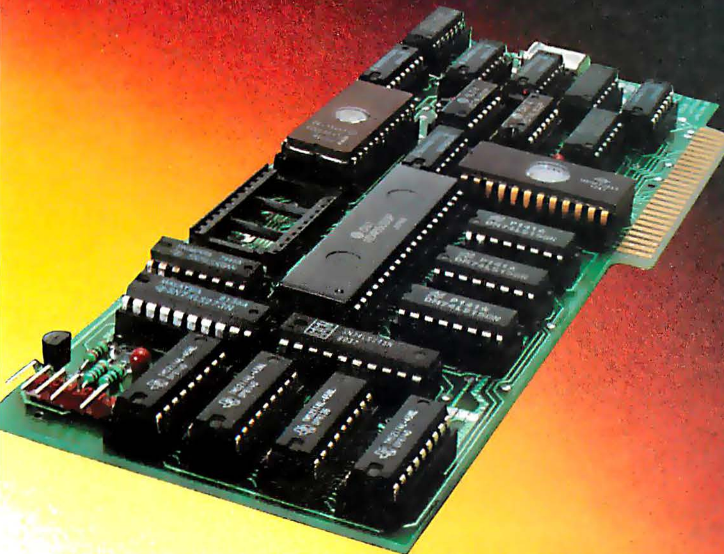
BYTE's Bits

Experimental Circuit Package Described

At a recent conference of the International Society for Hybird Electronics, a group of IBM engineers described an experimental circuit package that makes it possible to feed power and information to a complex bipolar logic integrated circuit. The package, with 200 pathways for electrical signals and 16 for power, links thousands of electronic circuits on the chip with the rest of the circuitry in the computer system. The thin metal-film pathways run between 216 connector pins and 354 pads connecting the chip to the package. Previous IBM circuit packages of this nature had a maximum of 96 signal paths and 132 pads, which means that the technique being worked on doubles the signal capacity and nearly triples the number of connection pads.

The chip is the result of an experiment to shrink the size of the IBM System/370's central processing unit to a single integrated circuit measuring one-quarter inch on a side. The System/370 contains nearly 45,000 transistors, resistors, capacitors, and diodes. ■

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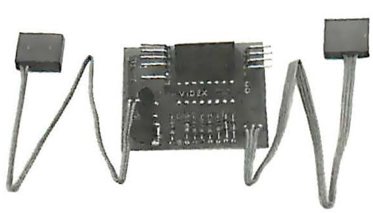


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Dvorak EPROM (Enhancer)—$29.00
Lower Case Chip (Rev 7 & up)—$29.00

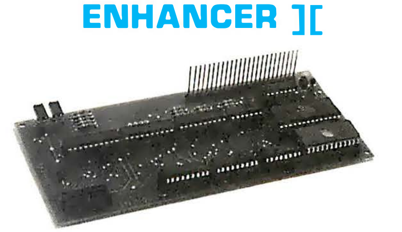
SOFT VIDEO SWITCH



The Soft Video Switch is an automatic version of the popular Switchplate. It knows whether it should display 40 or 80 columns or Apple graphics. It does the tedious work of switching video-out signals so you don't have to. The Soft Video Switch can be controlled by software. May be used with any Videoterm with Firmware 2.0 or greater. The single wire shift mod is also supported.

Package price is $35.00.

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The Enhancer][features a typeahead buffer. Your keyboard has upper and lower case, and will auto repeat any key held down. A single keystroke can become a word or an entire sentence. Controlled by a powerful microprocessor, Enhancer][allows you to re-map your keyboard or add specialized features. Changing a chip creates a totally different keyboard. Enhancer][Utilities Disc included.

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Copyrights, Computers, and the Betamax Case

Walter Klasson
77 Seventh Ave., 21P
New York, NY 10011

You've spent hundreds and hundreds of hours bleary-eyed in your computer's glare, hoping that your late-night programming obsession really will pay off. You've missed your favorite television shows and your daughter's childhood. People look at you strangely and ask where you've been. Your wife joins Computer Widows Anonymous.

Then one day your great software masterpiece is finally finished. You call out to your wife and kids, and the entire family at long last sits laughing together around your flickering video display, playing your new science-fiction and fantasy computer game, The Beast That Ate Hoboken.

Copyright is such an absolute right that even "innocent" unauthorized copiers, who may not have known that what they were copying belonged to someone else, are chargeable with infringement.

But someone out there wants to destroy your happiness. He buys a copy of your program only to give or sell a copy to a friend. Maybe the friend gives or sells copies to other people. Maybe the evil spreads. Your royalties fall off. You miss a payment on little Janie's teeth. You can't afford that 10 megabytes of hard disk you wanted. Is there no hope for you anywhere?

Yes, said the United States Ninth Circuit Court of Appeals this past October in what is known as the "Betamax Case." Sitting in California, that middle-level federal court determined that anyone who uses a video-tape recorder (VTR) to make a copy of copyrighted material without permission has infringed upon the copyright owner's statutory rights, even if the copier had no intention to sell the copy to anyone else. While computers weren't involved directly in the Betamax Case, this aspect of the decision seems to apply equally to unauthorized duplication of copyrighted computer software.

This legal development is not so

About the Author

Walter Klasson, an attorney with a specialty in computer law, is a member of the working group of the New York State Bar Association Subcommittee on Computer Law, which is considering a computer crime statute for New York. Mr. Klasson is author of a machine-language (Z80) word-processing program and president of Softlaw Inc., a consulting firm which specializes in adapting microcomputer/word-processor systems for small law offices.



Amdek's Video-300 green phosphor monitor is the easy-reading choice for almost any system — including IBM and Apple.

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Circle 18 on inquiry card.

surprising, although the Ninth Circuit Court did have to reverse the contrary decision of the federal district court below. The Ninth Circuit rejected the argument that so-called noncommercial, personal use should be considered noninfringing under an implied exception to the copyright statute. The court also interpreted the statutory "fair use" exception to the copyright owner's exclusive rights as applying only where the unauthorized copier used the copyrighted material for limited "productive" purposes, such as "criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship, or research." The exception does not apply where the copier merely wanted to use the copied material for the ordinary purposes for which it would be sold.

This part of the Betamax decision seems reasonable enough to me. After all, as the court said, the unauthorized copying of a television program or a movie that is for sale by the copyright owner is in fact quite "commercial" in that it "tends to diminish the potential market" for the product. It is not hard to agree that illegal copying, even for personal use, of someone else's copyrighted "intellectual" property is no more "innocent" then taking anything else of value belonging to another.

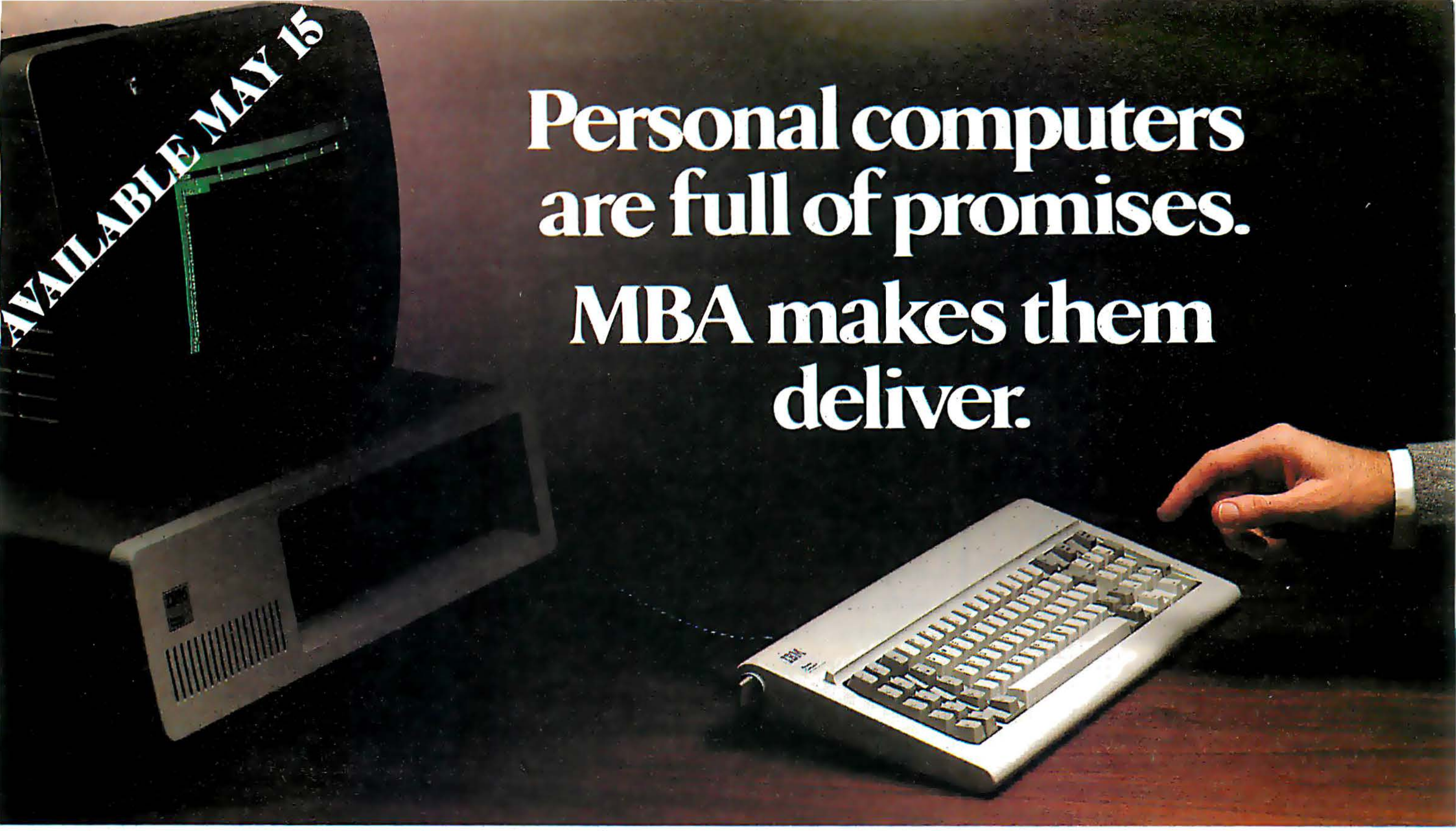
The results so far in the Betamax Case may have been of some small comfort to authors and sellers of word processors, computer games, and other relatively inexpensive software (i.e., virtually everything used on a microcomputer), which is easily copied on the rapidly increasing numbers of small computers being sold. But, at least, their copyrights (like those of Walt Disney and Universal Studios, the victorious parties before the Ninth Circuit) have been fully supported by the court.

However, copyright owners of mass-distributed software still face the impracticalities of enforcing numerous separate small claims against individual infringers even though the cumulative dollar loss from widespread software piracy may be very substantial. Unlike phonograph records, for example, microcomputer software doesn't have to be copied on relatively centralized and specialized counterfeiting equipment, which can be discovered and closed down. On the contrary, as with VTRs, the small-computer software pirates can do their dirty work in the privacy of the home, with little special expertise, cost, or equipment. Also, many small software houses simply don't have the resources necessary to go after the infringers they do suspect. Manufacturers of expensive software for larger computers, whose customers are usually a limited number of relatively responsible business organizations, don't share these problems. In short, although the Ninth Circuit's opinion labels most unauthorized copiers of small-computer software as copyright infringers, the practical difficulties of enforcing the copyright owner's legal rights remain.

While the first part of the Betamax decision could have been predicted, the second part is potentially a very significant new legal development. The Ninth Circuit also decided that the *manufacturer* and *sellers* of a VTR on which illicit copies are made (in this case, the defendants were various divisions of Sony, its advertising agency, and four retail stores) are equally liable for copyright infringement. Even more interesting, the court suggested that a possible solution to the video-tape piracy problem would be to charge the VTR manufacturers a royalty to be paid to the copyright owners. Think of the possibly staggering implications in the halls of Xerox of this novel legal conclusion if it were applied to photocopiers!

"Aha," the small-software author might think upon hearing this news, "a manufacturer of computer 'reproduction' equipment (for example, disk drives, cassette players, or any system incorporating them) is a big enough target for me to sink my legal teeth into for some relief (i.e., money) for all this pirating of my Beast That Surfed at Santa Cruz computer game."

Still, maybe the sound of eyeballs dropping out of heads did not accompany receipt of the news of this part



You've heard how the personal computer is going to revolutionize the way you work.

So far, the reality hasn't measured up to the promises.

But now there's a remarkable new software package that transforms the IBM Personal Computer into an incredibly powerful management tool (Apple and Xerox owners: read on).

The first totally integrated management software.

There are a lot of useful programs available for personal computers.

Unfortunately, they all seem to use different commands and different ways of storing data. This creates two major problems:

1. Every time you want to add a new function, you have to learn a whole new command language.

2. You may not be able to exchange data between different programs.

But now there's a better way. It's called the MBA, and it was created by a blue-chip management consultant, an MIT-trained systems designer, and some of the country's most experienced business programmers.

For the first time, MBA combines all the essential management functions in one easy-to-use package:

Electronic Spreadsheet. The ultimate financial modeling tool that lets you create a giant spreadsheet of figures and text. Change one number, and every affected item is instantly re-calculated.

Word Processing. Compose, edit, and print any kind of document. Make revisions yourself—faster than you can explain them to your secretary. Because MBA is an *integrated* system, it's easy to incorporate data from its other modules into a report you're writing.

Data Management. A sophisticated electronic filing system that lets you store information—ANY information—then retrieve it, analyze it, and generate reports to your specifications.

Graphic Output. For those occasions when a picture tells your story better than words, you can easily generate clear, readable graphs.

Communications. Tie into your company data center, a financial information service, or virtually any other computer system. MBA automatically retrieves the information you want, and lets you edit or rearrange it with a few keystrokes.

Easy to learn. Easy to use.

MBA's designers devoted great care to giving it a simple, consistent set of commands. So when you've learned one module, you'll immediately be comfortable with the others.

What, where, and how.

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of the Betamax decision wherever they make or sell disk drives. A brief legal and political explanation is in order to explain how the court found the VTR manufacturers liable along with the copiers and why, nevertheless, Tandy, Apple, Shugart, Percom, and many others may not have to raise their prices to pay royalties so that software authors can retire in luxury (or afford new shoes).

Copyright is such an absolute right that even "innocent" unauthorized copiers who may not have known that what they were copying belonged to someone else are chargeable with infringement. The difference in potential liability is that "innocent" unauthorized copiers, as opposed to deliberate infringers, might escape liability for full statutory minimum money damages, although they would probably be subject to an injunction (a court order that they not repeat the infringing behavior).

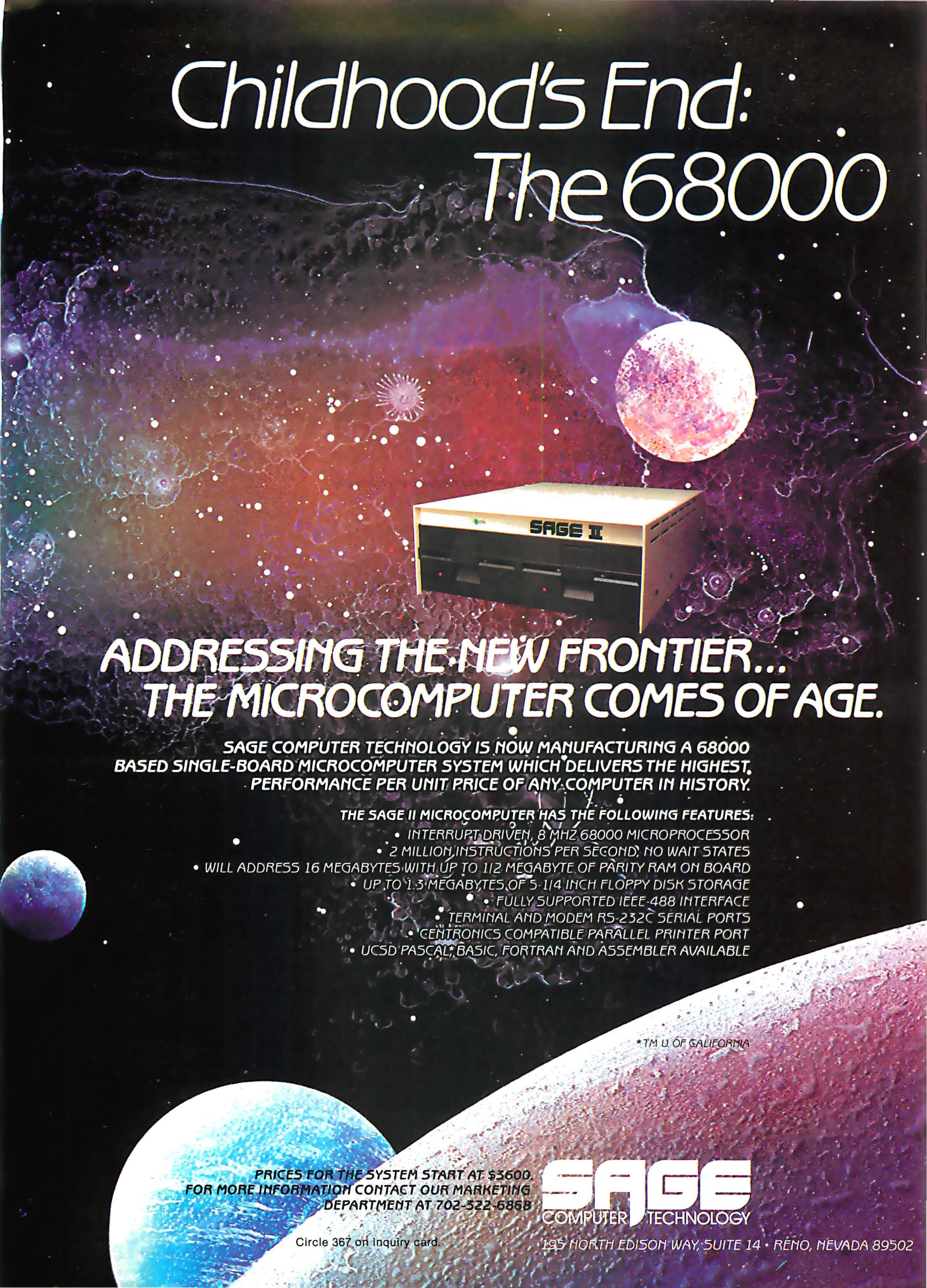
In the Betamax Case, however, the Ninth Circuit found that the defendants were not innocent, in that (although the legality of taping television broadcasts was in question) they knew that VTRs would be used to reproduce copyrighted materials and were in fact manufactured, advertised, and sold with that primary purpose in mind because virtually all television programming is copyrighted. The court therefore charged the manufacturers with "contributory infringement." On the other hand, the court, facing the reality of a popular and growing multimillion-dollar industry recognized that an injunction (i.e., shutting the industry down) might not be appropriate and that the whole question of providing relief for the copyright owners was "exceedingly complex." But while suggesting the royalty mechanism, the court directed the district court below (which must, in the first instance, fashion the relief for the winning side) not to "be overly concerned with harm" to the VTR manufacturers.

Thus, by this time every good attorney who represents a manufacturer of modern technological "reproduction" equipment of any kind is busy "distinguishing" the Betamax Case—that is, showing how his client's circumstances are significantly different from a VTR manufacturer's so that the Betamax decision should not apply. An obvious distinction in the small-computer area is the lack of any "free" source of copyrighted software for computer system buyers comparable to the extremely widespread broadcast of television programs. However, "the airwaves are free" argument sometimes heard (that copyright owners should lose their rights by broadcasting their works) is likewise not available in defense of computer software piracy, which is a more clear-cut form of infringement.

Another important distinction between VTRs and small-computer systems is that most of the latter are *not* promoted primarily as a means of duplicating copyrighted software but rather as *requiring* the purchase of certain copyrighted software (e.g., operating systems) and facilitating the general use of other purchased copyrighted applications software. Fully programmable systems even facilitate the creation of more copyrightable software, which is supportive of copyright's goal of promoting creativity. In contrast, what percentage of VTR owners have or really use video cameras?

In other words, even if you agree with the Ninth Circuit's implicit determination that most VTR owners are potential copyright infringers, most small-computer owners probably aren't. So it would be much more difficult to argue that most small-computer manufacturers and sellers were profiting from or encouraging copyright infringement to such a degree that they should be held liable as contributory infringers.

Even VTR manufacturers may not have to worry about the Ninth Circuit's Betamax decision. First, although at this writing it is still too early to know exactly what legal steps will be taken, Sony is likely to appeal to the United States Supreme Court which could reverse (or affirm) the Ninth Circuit on any number of grounds that could be more (or less) favorable to manufacturers of various types of reproduction equip-



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ment. Second, and perhaps more important, the United States Congress may act to set limits on copyright law. While copyright protection is mandated by the Constitution, its exact limits (such as the scope of its "fair use" exception) are a matter of federal statute. Within six weeks of the Betamax decision, at least one bill that, if enacted, would effectively overrule the Ninth Circuit was introduced in each house of Congress.

It is easy to imagine the vast industrial forces that might be arrayed against the Betamax decision, although the decision also has many important supporters among the owners of television, movie, and other copyrights. Intensive lobbying is probably now taking place, but Congress is likely to defer final action until the Supreme Court has spoken, which probably won't be before the fall of 1982. "Friends of the court," representing various groups whose interests could be affected by the final judicial decision, may introduce additional briefs or arguments.

If the Ninth Circuit's Betamax decision is judicially or legislatively overturned, the problem of the enforceability of the copyrights on inexpensive mass-distributed software still remains.

If the Ninth Circuit's Betamax decision is judicially or legislatively overturned, the problem of the enforceability of the copyrights on inexpensive mass-distributed software will remain. If the decision is allowed to stand and if it should be extended to the small-computer industry, then any royalty imposed would probably be passed on to the purchaser in higher prices on the hardware affected, almost like a tax on the entire class for the presumed piracy of a lesser number of individuals. This could reduce sales slightly.

Granting that such a royalty mechanism is not a perfect remedy for the software piracy problem, it is still certain that if there is insufficient legal or economic protection for inexpensive mass-distributed software, its availability will be reduced accordingly. While the actual incidence and cost of software piracy are not precisely known, it is likely to grow rapidly along with increased sales of computers and could become an additional economic barrier to the emergence of new small-software sources. All software authors may have to contend with an unacceptable uncertainty as to the exact economic potential of particularly valuable and innovative software.

The value to a hardware manufacturer of numerous sources of software that supports its system has at last been admitted by no less than IBM in connection with its new Personal Computer. Tandy and Apple, whether they admit it or not, owe much of their small-computer success to the multitudes of independent software sources for their machines, each of which is also promoting the hardware. There is currently software of great practical or entertainment value (as well as the inevitable rubbish) for the microcomputer market that costs anywhere from $10 to a few hundred dollars. Much of this software is a product of a relatively individualistic, labor-intensive cottage industry. Many members of this cottage industry could not individually support the expense of a full-blown legal defense of their copyrights.

Perhaps the answer is some simple form of voluntary cooperation by those united in interest, as is done in other areas of copyright law. For example, many composers and songwriters are paid royalties from such organizations as the American Society of Composers, Authors, and Publishers (ASCAP) and Broadcast Music Inc. (BMI), which have been legally designed to collect an appropriate amount from those who want to play, perform, or otherwise "copy" the protected material (for example, radio stations). Some type of centralized, less voluntary royalty system established as the result of the

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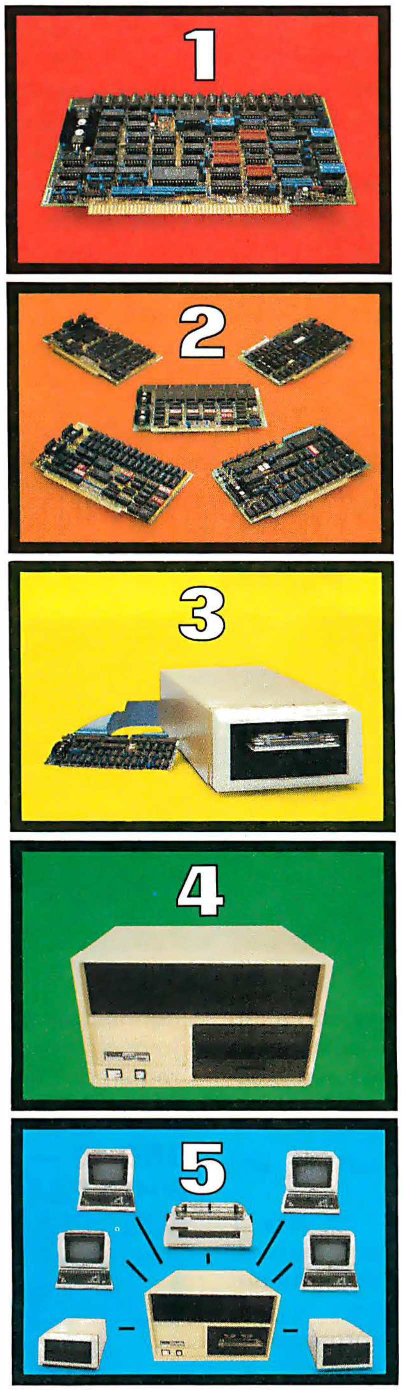
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Betamax decision could perform a similar function for software authors, unless Congress or the industry acts to produce some better method of protecting the copyrights involved.

Another legal alternative might be to increase deterrence to software piracy by increasing the criminal sanctions available against copyright infringers. However, this leads into the wholly separate area of computer crime (which is beyond the scope of this article) and away from the copyright law's primary focus on civil, not penal, enforcement of the statutory right. While greatly increasing the minimum statutory money damages awardable against deliberate infringers and including the copyright owner's legal fees in those damages might be effective deterrents, such measures, which would have to be enacted by Congress, do not appear to be under serious consideration.

Of course, assorted hardware-based technological solutions to the piracy problem, such as unduplicatable disks or ROM cartridges, exist. While often technologically effective, these methods are not always popular with users, limit the standardization and interchangeability of the various manufacturers' products, and don't encourage independent software sources to write for the machine involved. (A word of caution: those who provide information or equipment to defeat hardware or software antipiracy measures could be chargeable with contributory copyright infringement under the Betamax decision.)

It is therefore easy to predict, without knowing exactly what will or should be done, that the outcome of the Betamax Case and any other legal developments involving computer software piracy could have an important effect on the makeup of the small-computer industry. The courts have designed copyright law to promote human creativity. As the Ninth Circuit stated, "this purpose is to be achieved by reliance on the economic incentives granted to authors and inventors by the copyright scheme." Such a purpose is not being served where the more widely distributed and lower-priced products of human creativity may have the least effective protection because of technological and social factors. Perhaps, then, some form of royalty system for software copyright owners would help to remove the economic Catch-22 facing small-software authors as a result of the proliferation of small computers for which their programs are sold and on which their work may also be stolen. In any case, in the world of inexpensive computer software, events may now be taking place that will determine just what economic threshold must be crossed before copyrights are really of any value.■

Occasionally, BYTE invites industry leaders to comment on topics related to the microcomputer industry. The opinions expressed by these authors are their own and do not necessarily express the opinions of BYTE or its publishers.

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How to keep cool when your system goes down.



Everyone Can Know The Real Time

Technological advances have made real-time clocks simple and inexpensive.

Steve Ciarcia
POB 582
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It's almost three years now since I last discussed real-time clocks. Much has happened since I wrote "Anyone Know the Real Time?" (reference 1). Back then real-time clocks were usually put together either from existing digital watch or clock chips or from a series of TTL (transistor-transistor logic) counters. Microprocessor-bus-compatible real-time-clock chips were just emerging and were very expensive. I had to phrase my article title as a question.

Today, of course, real-time clocks are established, cost-effective products. The expense of adding a true millisecond-to-month time-of-day clock to a personal computer is barely more than the cost of the cheapest, most primitive clock of the kind in wide use just a few years ago. Today, with very little trouble, everyone who really wants to can know the real time.

This month I'd like to update the story a little and describe how to connect one of the latest products of real-time-clock technology to a microprocessor-based computer system, using a minimum-component circuit with battery backup, and I'll show how you can put together an intelligent clock that can function as a stand-alone peripheral device which communicates time data over a serial communication link to a remote computer upon command. But first, some background information.

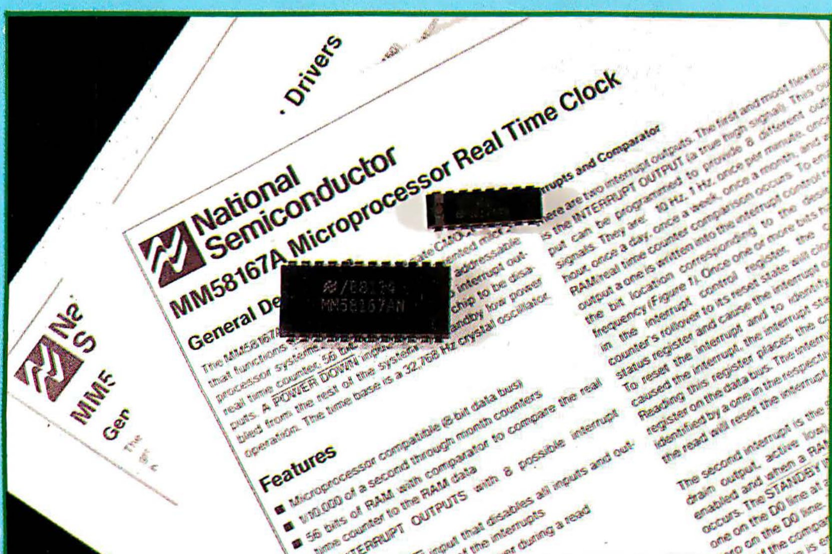


Photo 1: *No longer must we assemble real-time clocks from digital-watch parts or from small-scale-integrated circuits. National Semiconductor has introduced two components that do all the hard work: the MM58167A and the MM58174A.*

What Is Real Time?

Why do we need a clock to keep "real" time? Does this mean there exists "unreal" time?

Before we think too hard about what seems to be a philosophical conundrum, let's consider for a moment a typical application where a computer monitors a number of physical parameters and triggers a series of sequentially timed control outputs in response to certain changes in the parameters.

Suppose you have a computer controlling the lights in your home and that you want the control computer

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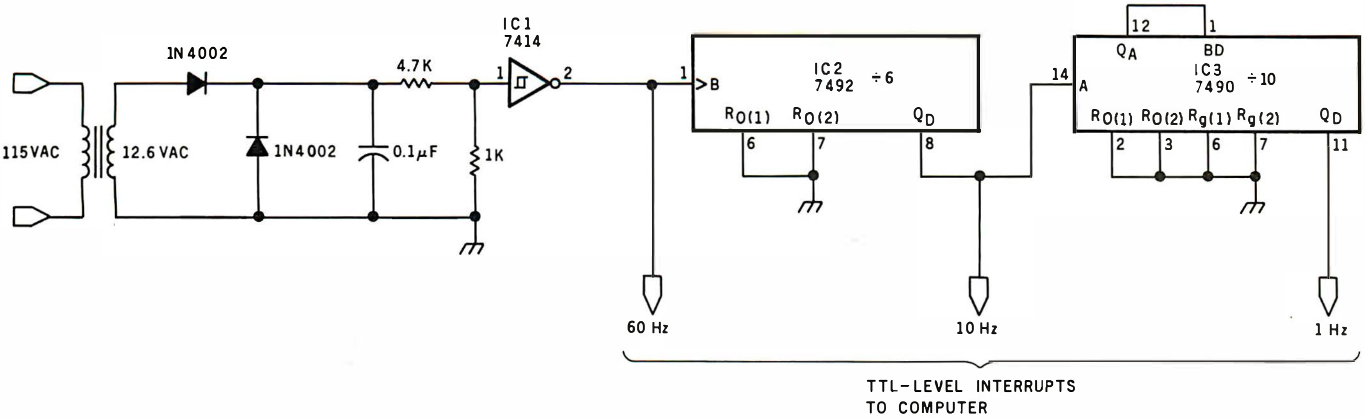
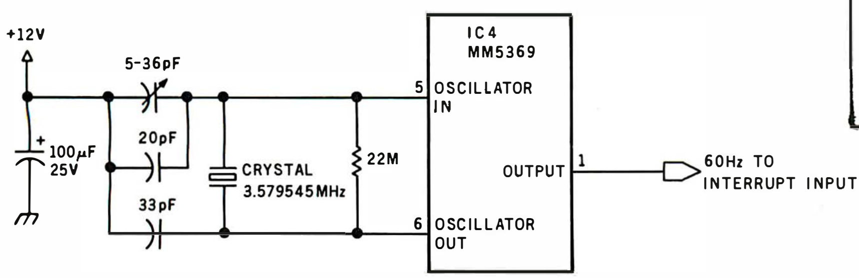


Figure 1: *Schematic diagram of a simple real-time clock that uses the 60-Hz power-line frequency as a reference. This provides the computer with only regular pulses or "heartbeat ticks"; the time of day must be kept by software.*



Number	Type	+5V	GND	+12V
IC1	7414	14	7	
IC2	7492	5	10	
IC3	7490	5	10	
IC4	MM5369		8	2

Figure 2: *A simple real-time-clock circuit that relies on a crystal oscillator for its timebase. As in figure 1, the only output is a series of regular pulses.*

to be able to tell when you are arriving home so that it can turn on the entrance light and turn it off when you get inside.

One way of setting up such a system is to place a pressure-sensitive switch under the doormat with a connection running to one of the computer's control inputs. As you approach the door and step on the mat, the computer's job is to sense the switch closure and turn the light on for, say, 200 seconds before turning it off. To perform these operations, the computer must be directed by a program which embodies a control algorithm that says, at least in part, "Turn the light on when the switch is closed, and then turn the light off later."

Now here's the catch. An algorithm cannot by itself tell how long the computer's hardware takes to perform any part of the algorithm. But you will be quite aware of how long the entrance light stays on, as directed by the control algorithm. So the algorithm must use some means to make 200 seconds pass in your real perception before turning the light off and moving to other tasks.

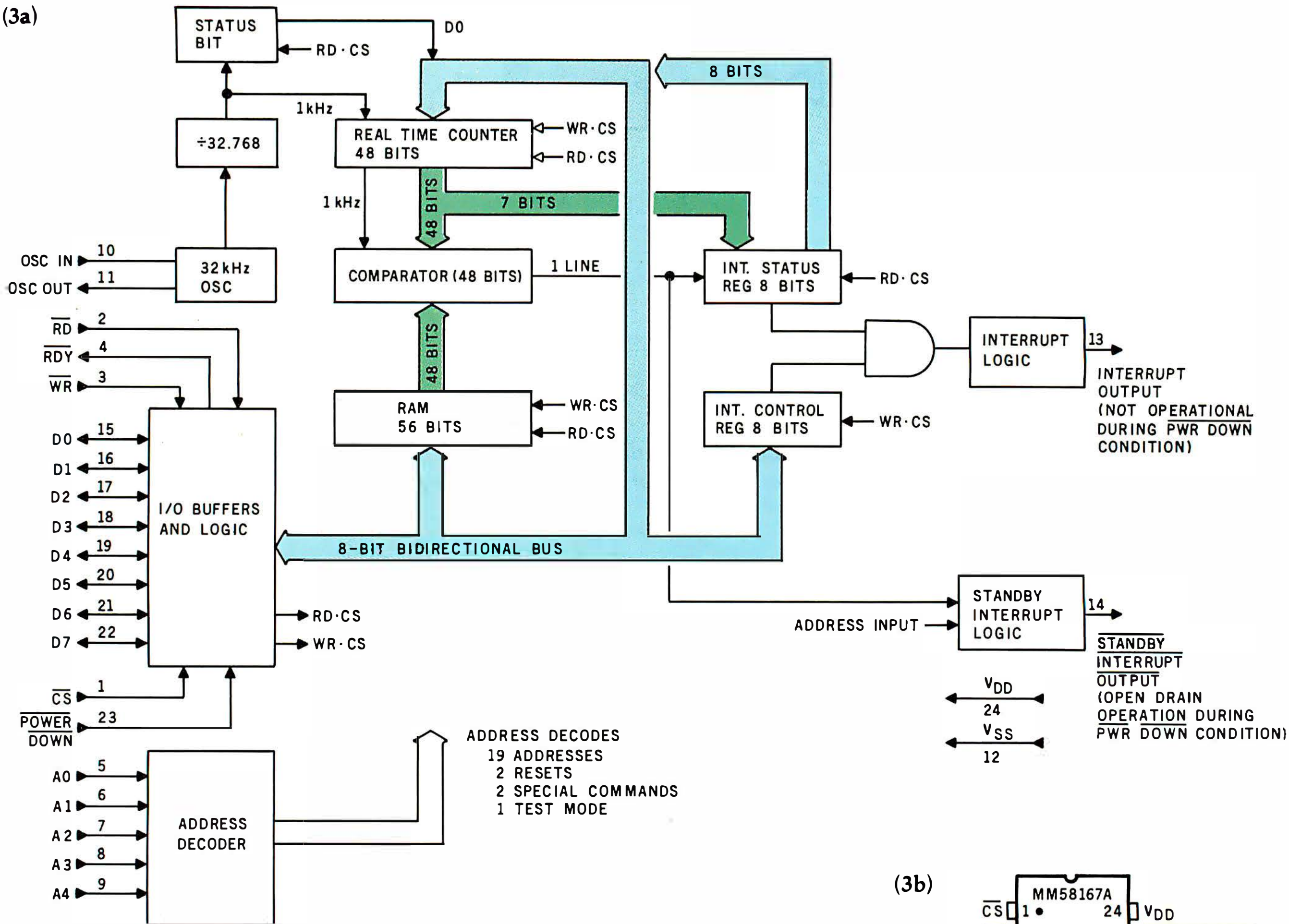
This is what we mean when we say that a computer keeps track of "real time." An algorithm that may execute at different speeds on different hardware is tied to external events. A hardware circuit or hardware/software combination that accurately records time with respect to an external observer is called a real-time clock.

Limitations of Software Timing

In our simple entrance-light application, it's not very hard to write a program that will satisfy us. We can use a short BASIC program that monitors an input bit and sets an output state, incrementing a counter variable in a FOR. . .NEXT loop to provide the 200-second delay. Perhaps 5000 iterations of a 40-ms (millisecond) loop would do the trick.

But what happens if the problem becomes more complex? Suppose we have a second light inside the house and a second mat with a switch under it, with a similar need for the computer to turn the light on for a specified duration. We have to add another set of delay statements to our simple BASIC program, and when we add something, it changes the execution time of the original timing loop. While we could make the FOR. . . NEXT-loop method work for two lights, the complications mount quickly as the problem becomes larger.

(3a)



(3b)

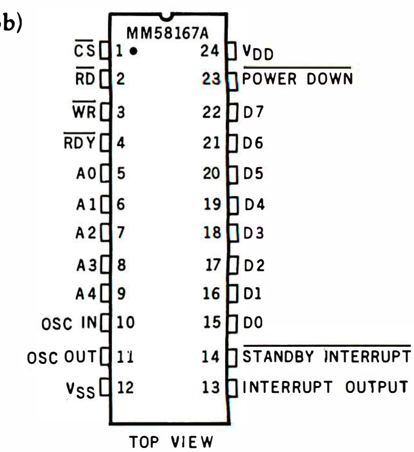


Figure 3: *Block diagram (3a) and pinout specification (3b) of the National Semiconductor MM58167A Real Time Clock. This integrated circuit and the MM58174A are advertised as being available from several distributors, including Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002, (415) 592-8097.*

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We escape the convolutions of the software approach by using special hardware circuitry that maintains a record of true elapsed time irrespective of software execution speeds. These circuits can take many forms, but generally such real-time clocks fall into either the time-of-day or "heartbeat-interrupt" category.

The *heartbeat-interrupt* clock is less expensive and uses fewer or simpler components, but more software interaction is needed to perform all the housekeeping chores, while a *time-of-day* clock does almost everything with hardware, requiring relatively little interaction with software.

Heartbeat-Interrupt Clocks

Figure 1 and figure 2 on page 35 show examples of two heartbeat-interrupt circuits, which were the feature attractions of my previous article. The circuit of figure 1 uses a crystal as a convenient timebase, while the circuit of figure 2 uses the 60-Hz power line. Both produce a single regular pulse (a clock "tick") at intervals of some precise fraction of a second. (Typical systems produce a tick at intervals of 1/60, 1/40, and 1/10 second.) The output line of the circuit is connected to an interrupt input on the processor.

Every time the clock ticks, the processor stops what it is doing and increments an elapsed-ticks counter in memory. When the processor needs to know the real time, it must calculate the time from the number of ticks. For example, using a 1/60-second timebase, a count of 10,860 corresponds to 181 elapsed seconds.

Generally, a computer system with a heartbeat-interrupt clock is initialized with the time of day when it is turned on, with the initialization time stored either in the ticks counter (which is said to count ticks from midnight) or in a separate location (to be summed with the ticks when the value of the time is needed).



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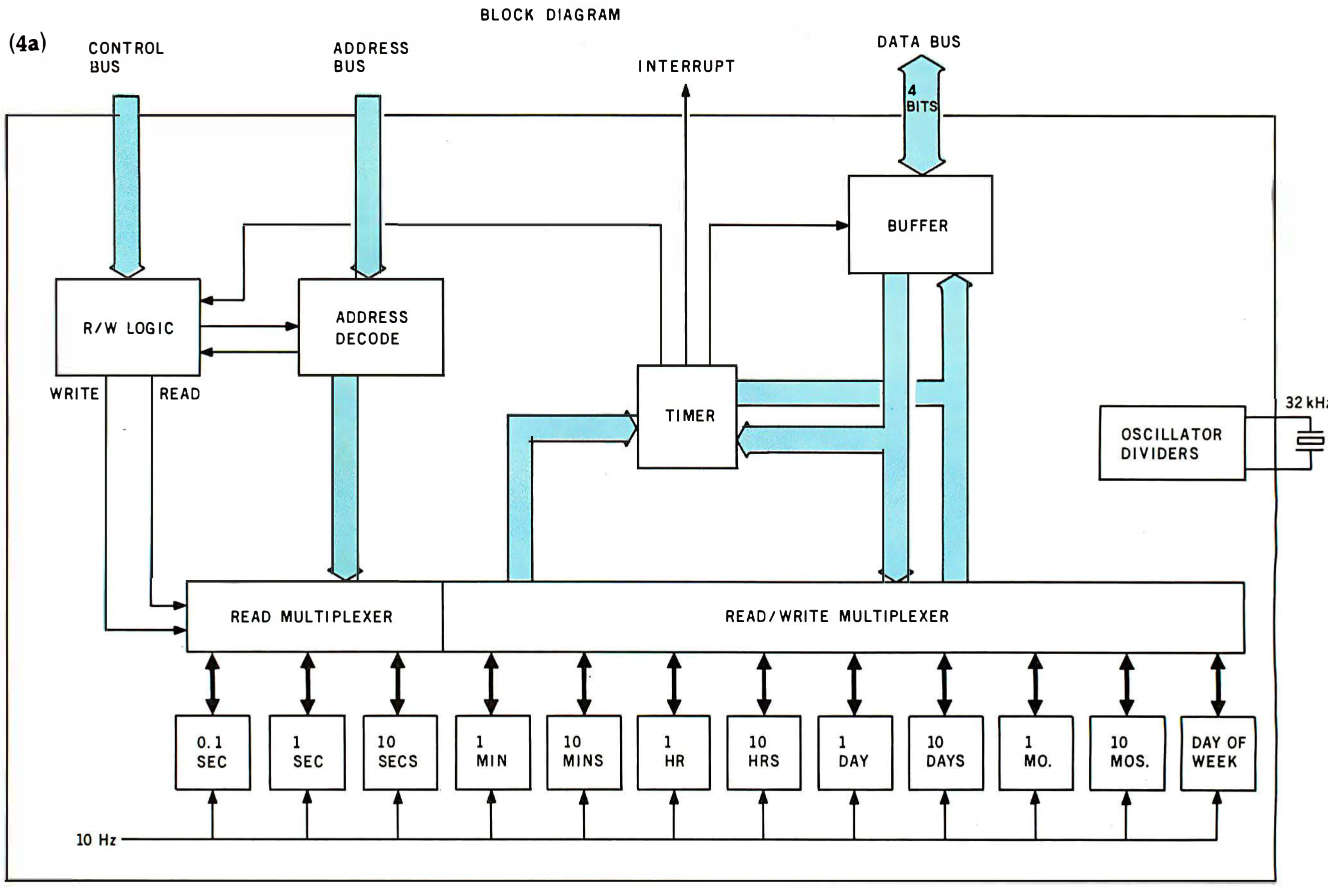
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(4a)



(4b)

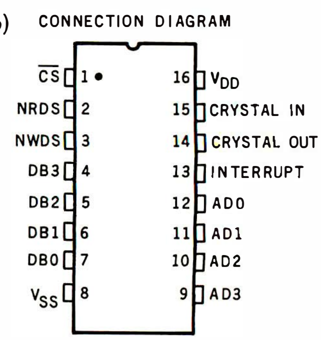


Figure 4: *Block diagram (4a) and pinout specifications (4b) of the National Semiconductor MM58174A Real Time Clock.*

The heartbeat-interrupt clock has some disadvantages. First, it is totally dependent on the processor's execution time and interrupt-handling capability. When the processor must interact with multiple peripheral devices, often there can be competition for the processor's attention. Computers from one major manufacturer actually ignore the clock at times, shutting it off while I/O (input/output) operations with the disk drive are taking place. The value of this clock is questionable because it loses a second or two with every disk operation.

The second criticism of heartbeat-interrupt timing is volatility. Since the time of day is kept only in software, the clock works only when the computer is powered. It is impossible to keep the clock running all the time without keeping power applied to the processor and part of the program memory, which can be an expensive undertaking.

What Is a Good Clock?

The ultimate solution is a separate hardware time-of-day real-time clock interfaced to the processor but running independently. Such a clock should keep track of the time of day to a resolution of milliseconds and should, with battery backup, never need to be reset. Additional features should include variable-rate processor interrupts (once per millisecond or once per month as required) and alarm-clock (coincidence of a preset time-of-day value) interrupts. Fortunately, these capabilities can be added to your system with a modest amount of hardware.

National Semiconductor Corporation has simplified the business of putting a versatile real-time clock in a computer by introducing two CMOS (complementary metal-oxide semiconductor) LSI (large-scale integrated) circuits, the MM58167A and MM58174A. These real-time-clock chips are designed for direct connection to the control and data buses of common microprocessors. Figure 3 on page 36 is a block diagram of the MM58167A, and figure 4 is a block diagram of the MM58174A.

Real-Time Clock: the MM58167A

The MM58167A is packaged in a 24-pin DIP (dual-inline package) and contains a 48-bit (14-digit) counter chain clocked from a 32,768-Hz

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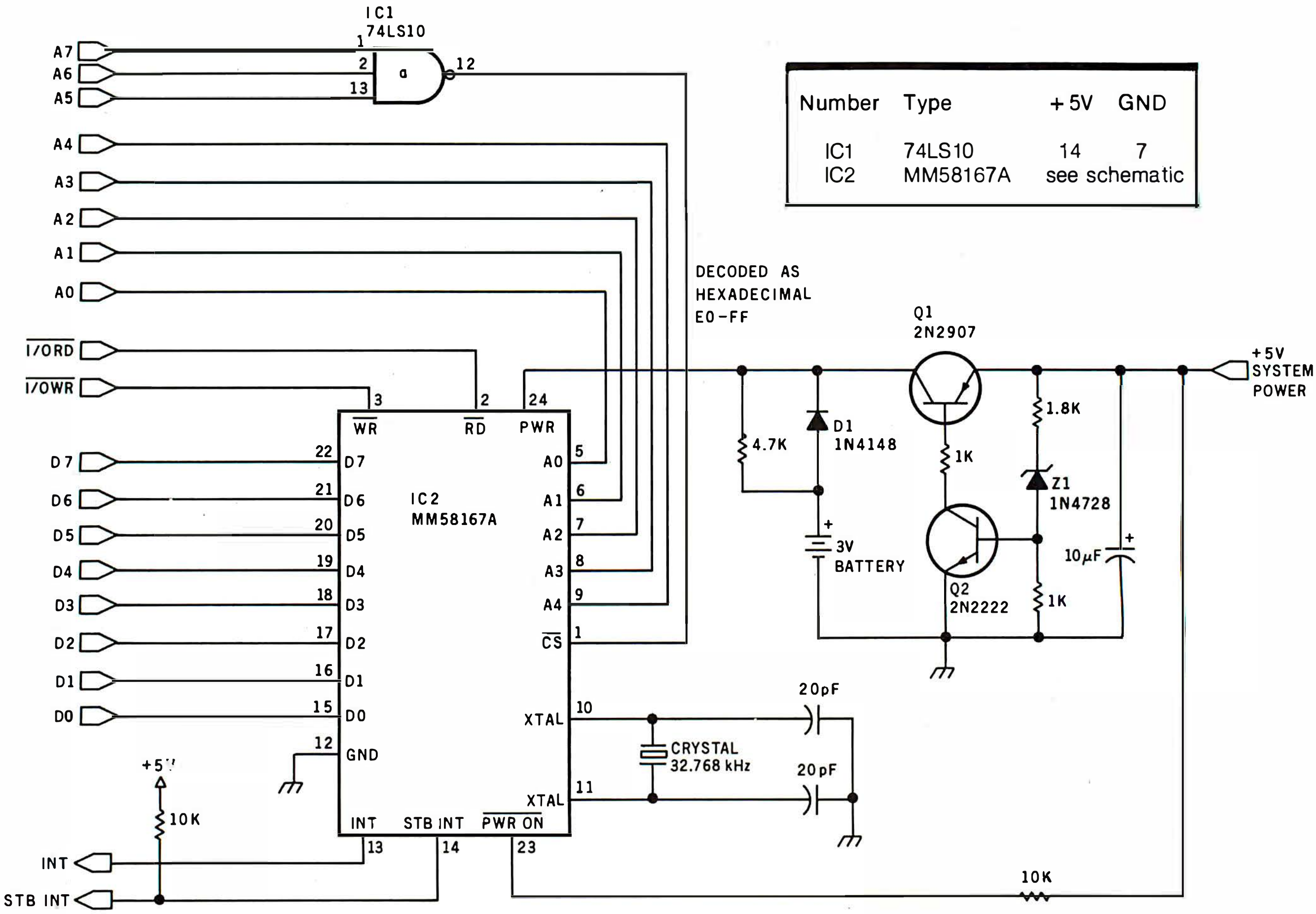
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Number	Type	+5V	GND
IC1	74LS10	14	7
IC2	MM58167A	see schematic	

Figure 5: *Schematic diagram of a real-time-clock circuit employing the National Semiconductor MM58167A suitable for direct connection to the bus of a microprocessor-based computer system (Z80, 8080, or 8085). The clock registers are addressed by input/output instructions that reference a set of addresses mapped into the I/O-address space of the processor. Provision is made for keeping the clock running when the computer system is turned off by supplying power from two 1.5-V alkaline battery cells, which should maintain operation for several months.*

crystal-reference oscillator. The MM58167A can keep track of and communicate to the processor the time in any increment from 1/10,000 second to months. (Usually, submillisecond resolution isn't required except in critical instrumentation or arguments over processor benchmarks.)

The MM58167A contains a storage latch consisting of 56 bits of on-chip RAM (random-access read/write memory). With backup power from a battery supplied to the clock chip, this storage can be used to keep any desired quantity or time while the system is powered down, or, in the "alarm-clock" mode, to contain a value to be compared to the real-time counter (either in its entirety or against individual digits in the counter). Occurrence of a match between the storage latch and the counters is signaled on a maskable interrupt line called the Standby Interrupt, which is active in the low logic state.

Another output, called simply the Interrupt Output (active high), can provide the heartbeat interrupt described earlier. This output can be programmed to provide clock ticks at seven regular rates (ten times per second [10 Hz], once a second [1 Hz], once a minute, once an hour, once a day, once a week, and once a month) and when a comparison match occurs between the storage latch and the real-time counter.

Real-Time Clock: the MM58174A

National Semiconductor's second real-time-clock chip, the MM58174A, is a 16-pin integrated circuit with somewhat fewer talents (but a lower cost) than the MM58167A. The timing chain is derived from a 32,768-Hz oscillator, as in the MM58167A, and it counts time intervals from 1/10 second through months. The other major difference is the MM58174A's lack of the comparison-match interrupt. However, the MM58174A does have a tick interrupt programmable for intervals of 1/2 second, 5 seconds, or 60 seconds.

As I write this, the price/performance ratio of the 58167A is more attractive than that of the 58174A, so I have based my construction project solely on the MM58167A.

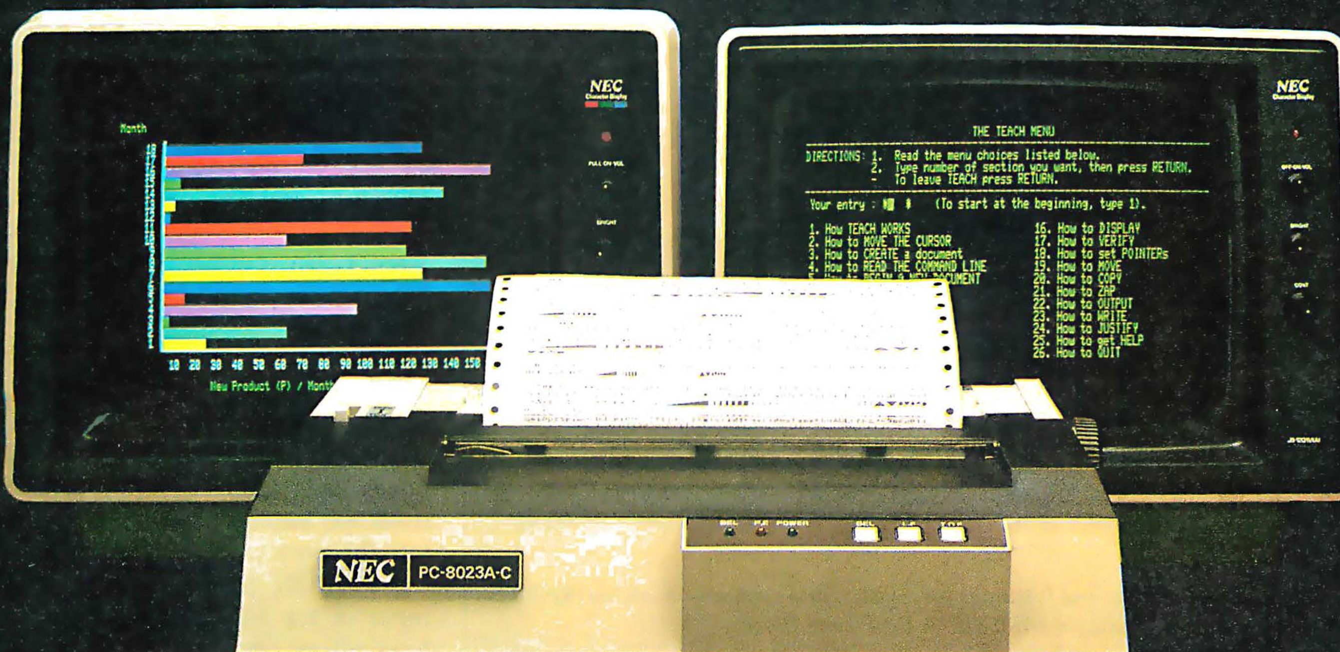
Real-Time-Clock Interface

Figure 5 is the schematic diagram of a real-time-clock circuit that incorporates the MM58167A. The circuit is

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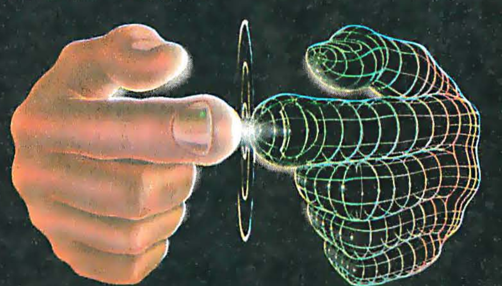


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A4	A3	A2	A1	A0	Function
0	0	0	0	0	Counter—ten thousandths of seconds
0	0	0	0	1	Counter—hundredths and tenths of seconds
0	0	0	1	0	Counter—seconds
0	0	0	1	1	Counter—minutes
0	0	1	0	0	Counter—hours
0	0	1	0	1	Counter—day of week
0	0	1	1	0	Counter—day of month
0	0	1	1	1	Counter—month
0	1	0	0	0	RAM—ten thousandths of seconds
0	1	0	0	1	RAM—hundredths and tenths of seconds
0	1	0	1	0	RAM—seconds
0	1	0	1	1	RAM—minutes
0	1	1	0	0	RAM—hours
0	1	1	0	1	RAM—day of week
0	1	1	1	0	RAM—day of month
0	1	1	1	1	RAM—months
1	0	0	0	0	Interrupt Status register
1	0	0	0	1	Interrupt Control register
1	0	0	1	0	Count Reset } see table 2
1	0	0	1	1	RAM Reset } see table 2
1	0	1	0	0	Status bit
1	0	1	0	1	Go command
1	0	1	1	0	$\overline{\text{Standby Interrupt}}$
1	1	1	1	1	Test mode

Table 1: *Address codes and functions for registers and comparison latches (RAM) in the National Semiconductor MM58167A Real Time Clock.*

relatively simple to attach to most personal computer systems, requiring only an 8-bit data bus and 5 address lines.

The read ($\overline{\text{RD}}$), write ($\overline{\text{WR}}$), and chip select ($\overline{\text{CS}}$) lines on the clock chip are similar to those found on memory devices. To read any register in the clock, external circuitry must place signals on the $\overline{\text{RD}}$ and $\overline{\text{CS}}$ lines while the proper address appears on the address lines; similarly, to write data into the clock registers, external circuitry must enable the $\overline{\text{WR}}$ and $\overline{\text{CS}}$ lines while the address appears. The data bus serves as the data path in and out of the counters and latches; values are loaded and read in BCD (binary-coded decimal) format. The 5 address lines allow activation of 24 counter and memory functions, which are listed in table 1. (The binary values are equivalent to hexadecimal 00 through 1F.)

The MM58167A can be attached to virtually any microprocessor bus. For example, in 6502- or 6800-based systems, the MM58167A would be addressed as 32 locations in memory-address space. As shown, the circuit of figure 5 contains signals designed to be decoded by the I/O bus of a Z80-, 8080-, or 8085-based computer, with the 24 clock-register addresses extending from hexadecimal E0 to FF. For simplicity and generality, I shall refer to particular registers in this article following the 00 to 1F coding of table 1. When you are using the circuit of figure 5, add hexadecimal E0 to these values.

Turned-Off Timekeeping

One important attribute of both the MM58167A and the MM58174A is their ability to operate from battery power when the computer-system power is off. Both chips will continue keeping track of the real time when supplied with power at voltages down to 2.2 volts (V). A small 3-V battery can easily supply the current required (only 20 μA [microamps], dissipating 44 μW [microwatts] of power).

The circuit of figure 5 contains provision for operating the real-time clock on battery power when the computer is turned off. Transistors Q1 and Q2 serve as a voltage-sensitive on/off switch. When the system power is on at a potential of +5 V, transistor Q1 conducts, supplying power to the MM58167A. Diode D1 blocks any large current flow into the battery, but the two alkaline cells do receive a slight trickle charge from the system power through the 4.7k-ohm resistor. In normal operation the MM58167A requires about 12 mA (milliamps).

When the computer is shut off and the +5-V supply drops to 0 V, Q1 opens to keep current from the battery from going onto the system's power bus. Current begins to flow from the battery through diode D1 into the clock chip. At the same time, the $\overline{\text{PWRDN}}$ (Power Down, pin 23) input of the MM58167A senses the low-voltage condition of the power bus and causes the clock to enter the powered-down operating mode.

In the powered-down mode, the clock's three-state I/O lines enter a high-impedance condition, effectively disconnected from the computer, and the current drawn from the power source is reduced from 12 mA to 20 μA. In this mode, which can be activated at any time by placing a 0-V potential on pin 23, the clock continues to keep time, but only the Standby Interrupt remains active (if it was enabled previously). Using the Standby Interrupt and some external power-control circuitry, you could set up your computer to shut itself completely off and then turn itself on automatically weeks later.

An Intelligent Clock

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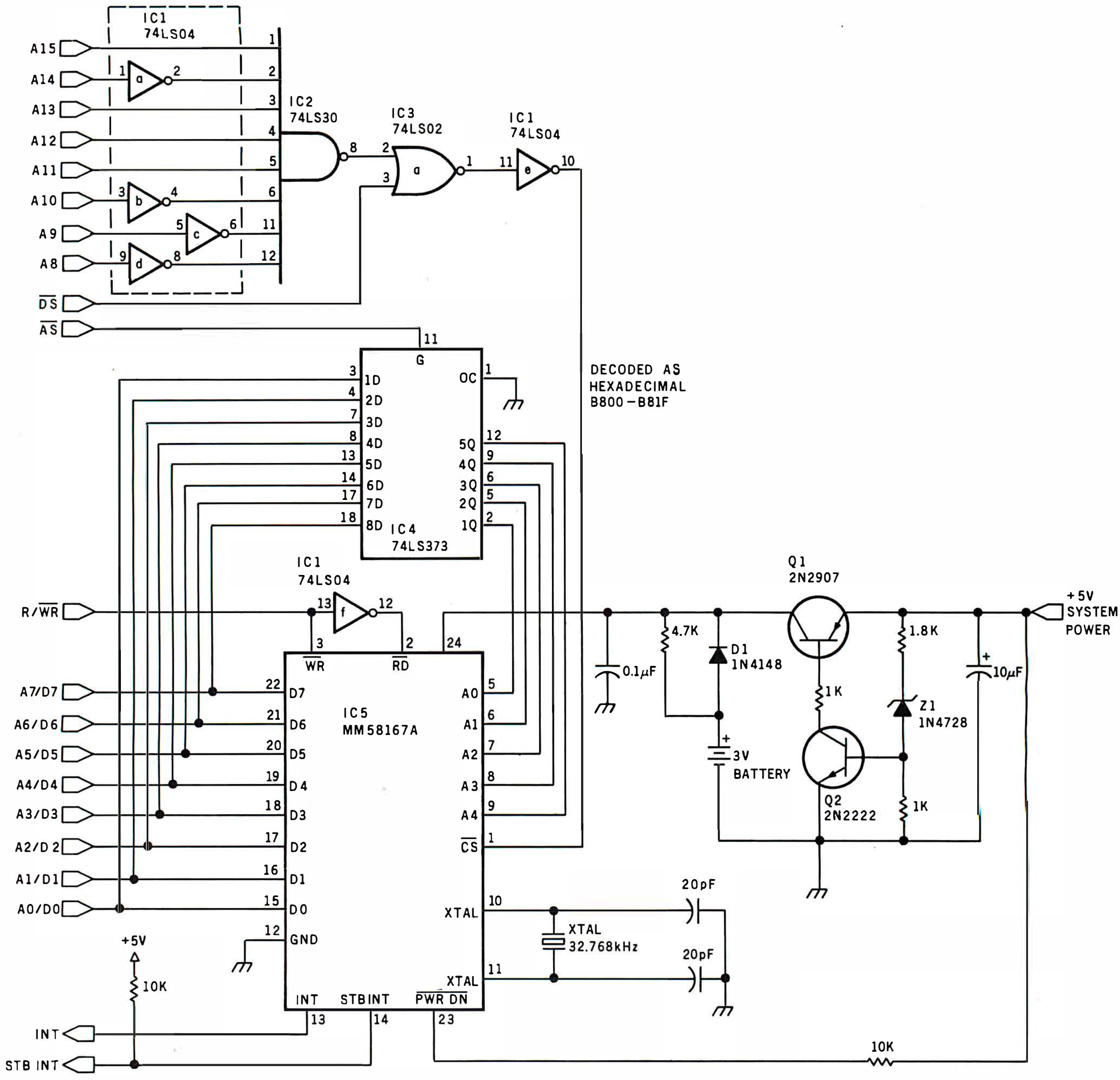
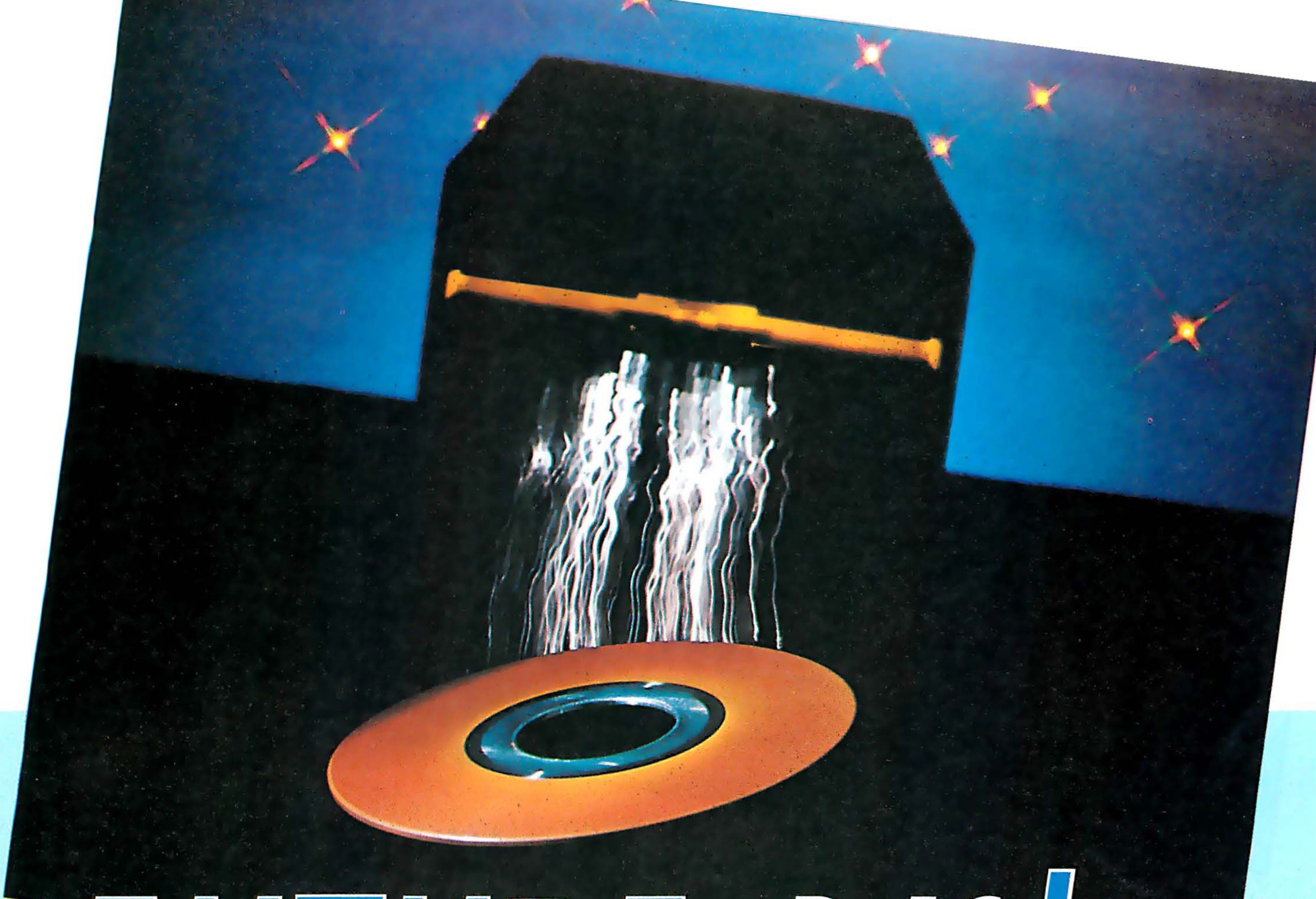


Figure 6: *Schematic diagram of a real-time-clock circuit that uses the MM58167A and the Z8-BASIC Microcomputer to constitute an intelligent peripheral device that can send information on the date, time, and its status over a serial communication line to a remote computer.*

bark on the sometimes dangerous course of modifying our computers. I have to admit to membership in this group to the extent that I don't dare mess with the one computer I use as my word processor. For that reason I wanted to develop an intelligent real-time clock that I could use as an external peripheral device for any computer. As with some of my previous projects, I found that the most convenient and cost-effective means of doing so was to use the Z8-BASIC Microcomputer that I developed last year (see references 2 and 3).

Using the Z8-BASIC Microcomputer, we can develop an independent real-time clock that can communicate over a serial data link with almost any computer. (You could use another single-board microcomputer with similar results.) We can have almost all the features of the bus-interfaced real-time clock as well as convenient output formatting of the date and time. By adding intelligence to the hardware, software interaction with the real-time clock can be removed from the realm of the operating system and handled by an application program instead.

Figure 6 is the schematic diagram of an intelligent real-time clock consisting of an MM58167A chip interfaced with a Z8-BASIC Microcomputer. (The nomenclature on the left side of the diagram refers to bus signals of the Zilog Z8.) The logic gates IC1, IC2, and IC3 are address decoders. The clock-chip interface is set up to occupy hexadecimal addresses B800 through B81F (corres-



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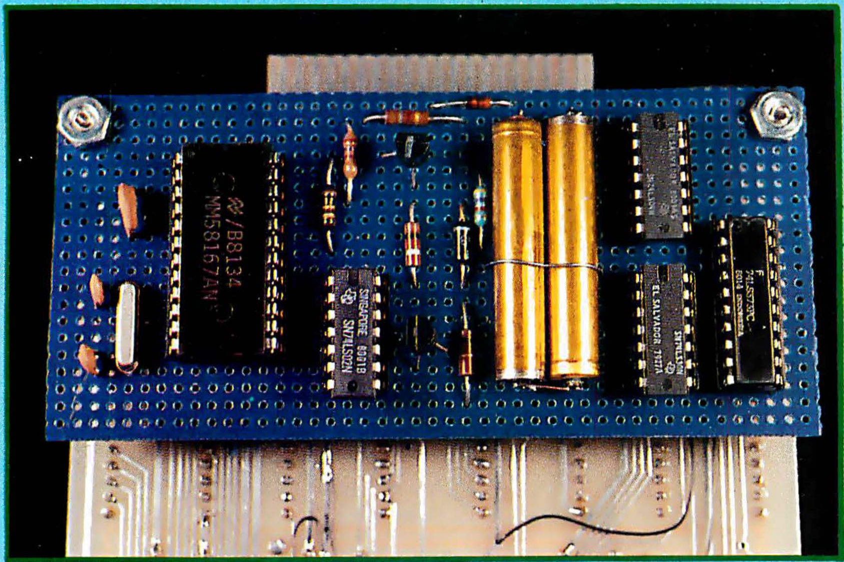


Photo 2: *The prototype of the real-time-clock circuit of figure 6, mounted on the back of a Z8-BASIC Microcomputer, which provides the intelligence and versatility of control of a general-purpose microcomputer.*

ponding to register addresses 00 through 1F on the MM58167A). The Z8 has a multiplexed address/data bus, so the octal latch IC4 is required to latch the 8-bit low-order address. Other than that, circuit operation is as described for figure 5, including battery backup.

Time-Data Representation

Now that I have described the hardware of the clock interface, we can turn our attention to how to use the real-time clock. Before we start writing programs in BASIC, assembler, or even FORTH, we must understand how the MM58167A stores in its registers the values that represent the current time.

Each unit of time is allotted a two-digit binary-coded-decimal register. Each register has a unique address within the clock chip, which is mapped into the address space of the external logic according to the range of addresses assigned to the clock chip; in the Z8-BASIC Microcomputer, hexadecimal B800 through B81F are the addresses of the clock registers as seen by the outside world.

The BCD internal representation of time is a slight inconvenience when we are programming in a high-level language; we can't directly load the registers with decimal values or read them with statements that assume decimal radix for arguments. But fortunately, the BCD representation maps directly onto hexadecimal representation for the set of numbers used for timekeeping, so we can load and read the registers using hexadecimal-radix operators, if our high-level language has them.

The BASIC/Debug interpreter of the Z8-BASIC Microcomputer can operate on hexadecimal data, identifying hexadecimal variables and constants with the percent symbol (%) as a prefix character. If your language interpreter has no such ability, you may have to explicitly code some decimal-to-hexadecimal (and vice versa) conversion routines.

Setting the Clock

The best way to describe the operation of the clock and the computer's interaction with it is to follow a sequence of setting and monitoring the time. For example, choosing a convenient time and date, such as 2:34 p.m. on Friday, May 14, we can set the clock.

First, all the counters are reset by writing hexadecimal FF to the counter-reset register, which lies at the internal clock-register address of hexadecimal 12. Then appropriate values for each time unit are loaded into the corresponding registers. For the date and time chosen, the decimal-radix values would be as follows (with the hours numbered in a 24-hour scheme):

month:	05
day of month:	14
day of week:	06
hour:	14
minute:	34

As I mentioned before, these two-digit decimal values must be represented in the clock in BCD format. If, for example, we tried to load 34 minutes into the minutes register (at clock address hexadecimal 0B, decimal 11) using the simple integer-arithmetic BASIC statement

```
OUT 11,34
```

the MM58167A would read the 34 as two BCD digits and interpret it as 22 instead of 34. To avoid this error, we use the equivalent hexadecimal-radix statement

```
OUT 11,%34
```

instead, with %34 understood to be a hexadecimal constant. (In the Z8-BASIC Microcomputer, the statement would be %0B,%34.) If your computer can't handle hexadecimal numbers, another possibility is to send 52, the decimal equivalent of hexadecimal 34. The statement

```
OUT 11,52
```

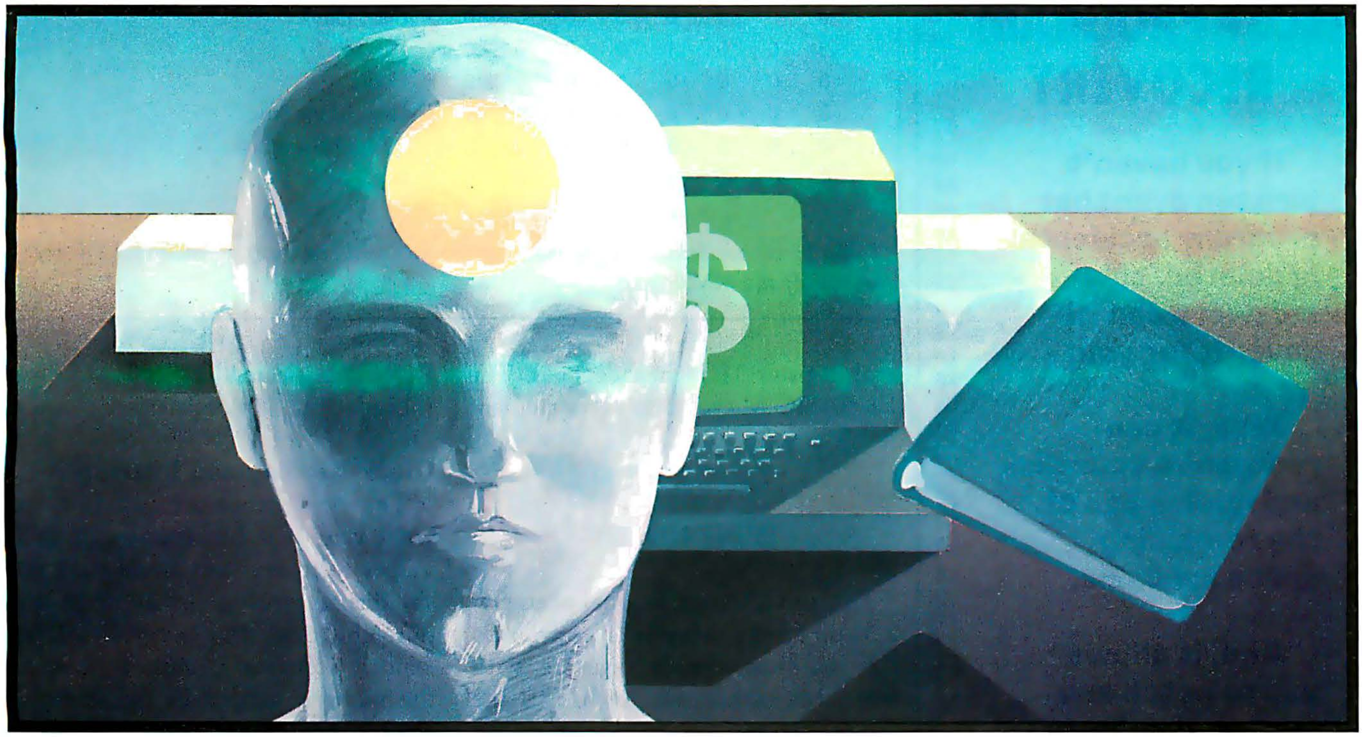
will result in 34 being loaded into the BCD minutes register.

The same problem exists in reading the clock registers. If you try to read the value of 34 minutes in clock register hexadecimal 0B with the BASIC statement

```
PRINT INP(11)
```

the interpreter will return the incorrect decimal value of 52 minutes. The solution is to print the value of deci-

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D0	D1	D2	D3	D4	D5	D6	D7	Counter or RAM Reset
1	0	0	0	0	0	0	0	Ten thousandths of seconds
0	1	0	0	0	0	0	0	Hundredths and tenths of seconds
0	0	1	0	0	0	0	0	Seconds
0	0	0	1	0	0	0	0	Minutes
0	0	0	0	1	0	0	0	Hours
0	0	0	0	0	1	0	0	Days of the week
0	0	0	0	0	0	1	0	Days of the month
0	0	0	0	0	0	0	1	Months

Table 2: *Bit specifications for the time-counter and comparison latch (RAM) reset format of the MM58167A.*

mal register 11 in hexadecimal. The Z8-BASIC Microcomputer statement is

```
PRINT HEX(0B)
```

Returning to our original example, 2:34 on Friday, May 14 is loaded into the real-time clock's registers with five write commands. In BASIC the statements are

```
OUT %0F,%05 (month)
OUT %0E,%14 (day of month)
OUT %0D,%06(day of week)
OUT %0C,%14(hours)
OUT %0B,%34 (minutes)
```

Next, a write pulse to hexadecimal address 15 is performed to reset the thousandths, hundredths, tenths, units, and tens of seconds counters to zero (the data on the address bus is ignored during the execution). This so-called Go command is used only for precise starting of the clock. If the seconds counter is at a value greater than 40 when the Go is issued, the minutes counter will be incremented; otherwise the minutes counter is unaffected. The Go command is unnecessary to start the clock, since the counters count whenever there is power. Instead, it is a convenient way to precisely synchronize at a given instant.

The time-unit counters and comparison (RAM) registers can be reset to zero at any time by setting the appropriate bits according to table 2 and writing to either the Counter Reset (hexadecimal 12) or RAM Reset (hexadecimal 13) registers.

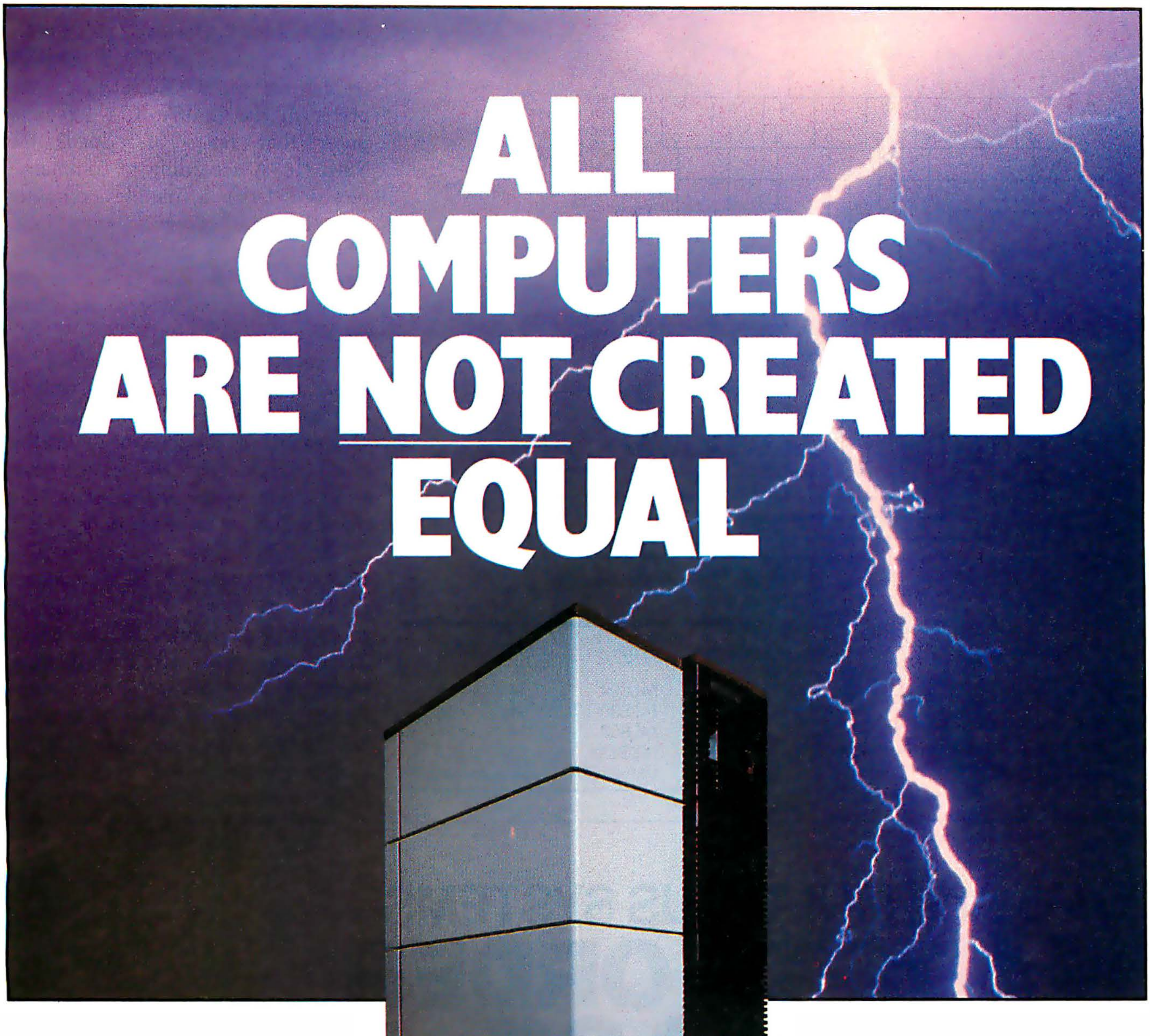
Clock Reading and Interrupts

The host processor can find out what time it is by reading the BCD values from registers 00 through 07. To display this information in any different form, you have to write an explicit software routine to convert the numeric output of the real-time clock to the desired format.

The Interrupt Output (pin 13) can be programmed to provide a signal at any of eight different times, as previously discussed. To enable one of these conditions, a logic 1 is written into the Interrupt Control register (hexadecimal 11) at the appropriate bit position corresponding to the desired output frequency. Figure 7 shows the functions of each bit position. (For example, writing hexadecimal 08—a 1 in bit D3—to the Interrupt Control register sets a once-per-minute interrupt.)

When a counter rollover that corresponds to one of the control-register settings occurs, the Interrupt Output goes high. The interrupt is reset by reading the Interrupt Status register (hexadecimal 10).

The second interrupt is the Standby Interrupt (active low, pin 14). This interrupt is enabled by writing 01 to the Standby Interrupt register (hexadecimal 16). The interrupt output occurs when there is a match in the comparison between the comparison latch (RAM) and the real-time counter. The interrupt in this case is reset by writing 00 to this same register.



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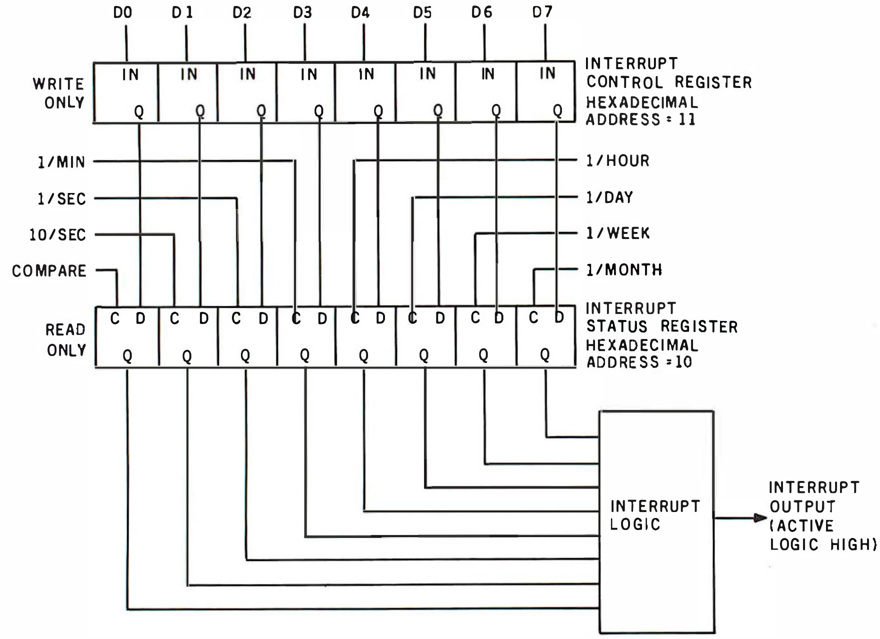


Figure 7: *Conceptual diagram of the assignment of bit functions in the Interrupt Control and Interrupt Status registers of the MM58167A.*

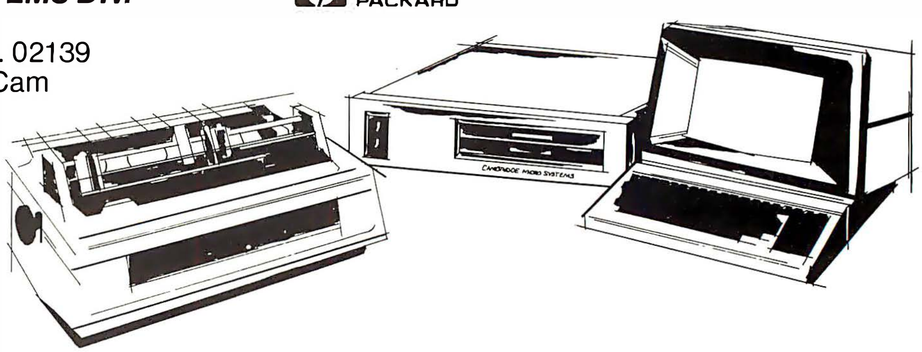
Number	Type	+5V	GND
IC1	74LS04	14	7
IC2	74LS30	14	7
IC3	74LS02	14	7
IC4	74LS373	20	10
IC5	MM58167A	see schematic	

Serial-Clock Software

Listing 1 on page 54 is a program written for the BASIC/Debug interpreter of the Z8-BASIC Microcomputer that reads and loads the MM58167A according to commands received from a remote computer over a serial communication link. This software is merely for demonstration and is not indicative of everything you might want in such an intelligent clock.

Because the intelligent clock of figure 6 has its own processor and battery backup, I felt it was unnecessary to include the code for setting the clock initially from the remote computer. For most applications, the clock will have to be set only once.

The subroutines starting at line 1000 allow the clock to be set using an off-line terminal. The program prompts you for entry of the current month, day, hour, etc. It waits after entry for you to issue a start command by pressing the space bar on the keyboard so that the clock can be synchronized with some time reference such as radio station WWV.



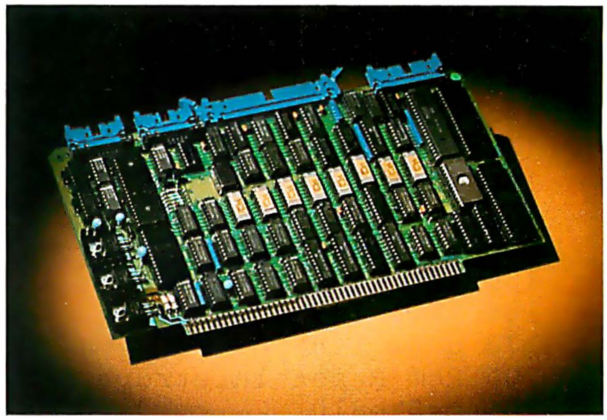
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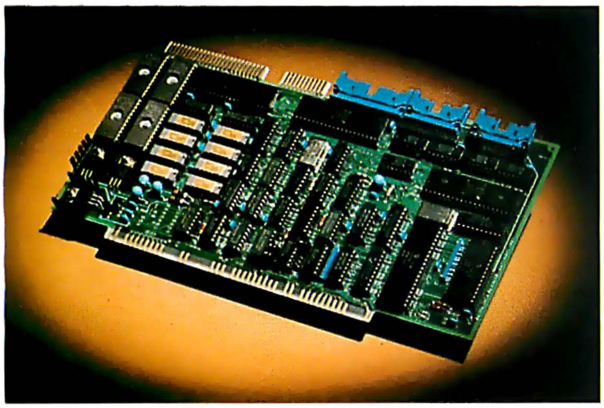
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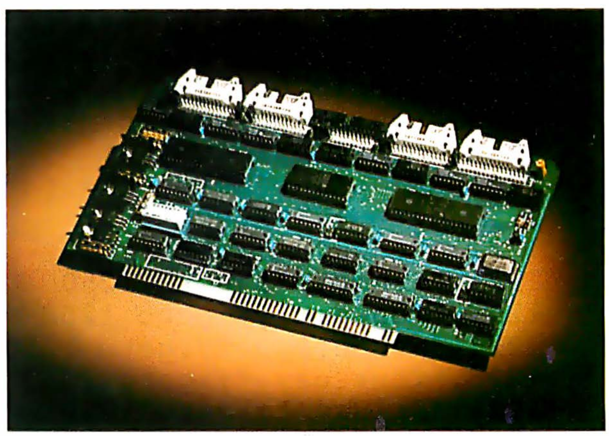
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Listing 1: *A BASIC/Debug program written for the Z8-BASIC Microcomputer and the MM58167A to allow them to function as an intelligent serial time-of-day clock.*

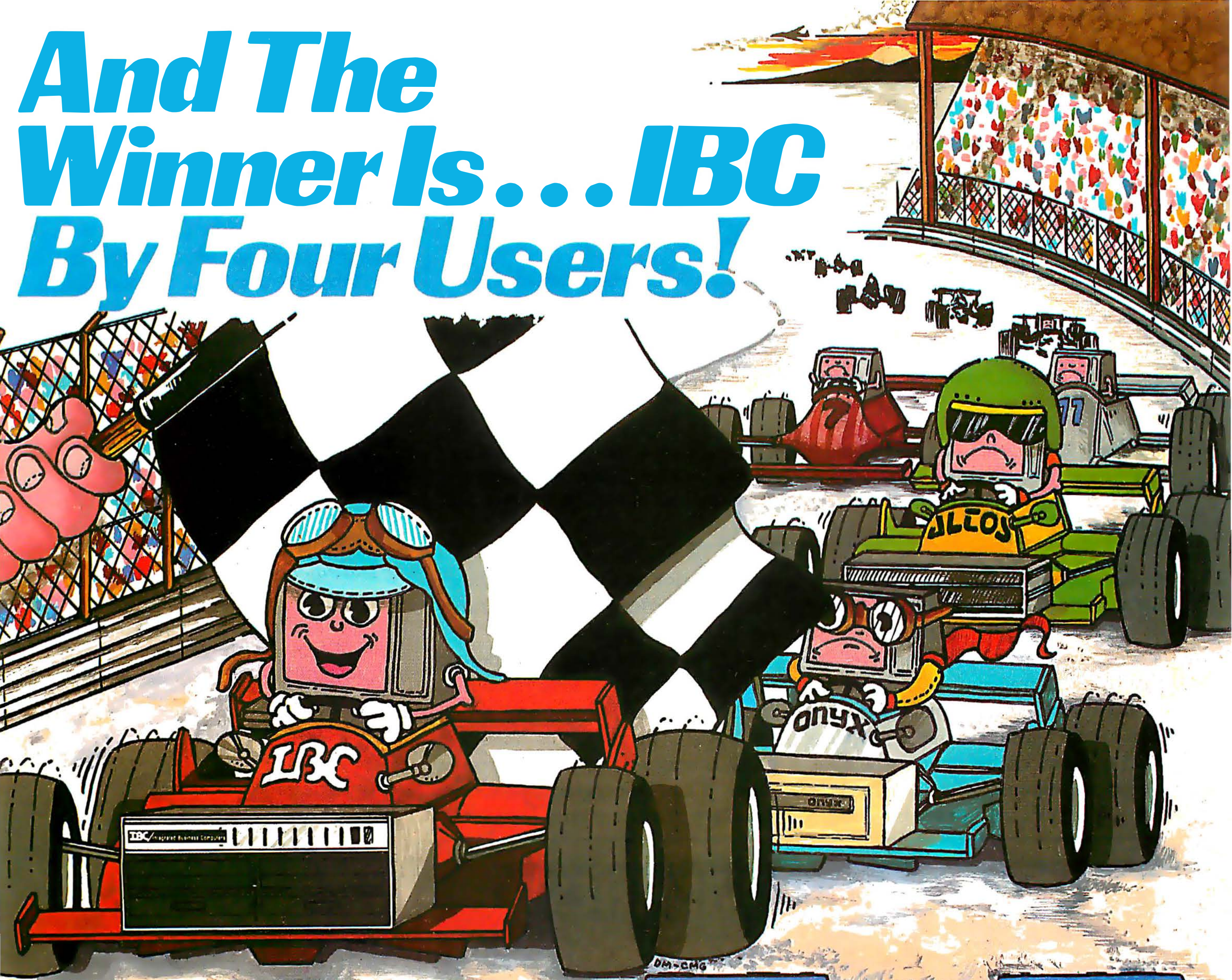
```
100 REM Serial Controlled Real Time Clock
110 Rem
130 a=%b807:b=%b806:c=%b805:d=%b804:e=%b803:f=%b802
140 l=@240
142 if l=161 then 148
143 gosub 600
144 goto 140
148 l=@240
150 if l=137 then 300
152 if l=146 then 200
154 if l=147 then 1000
156 if l=148 then 1300
158 if l=149 then 500
170 goto 148
200 Rem Reset Interrupt
205 m=@%b810
210 goto 140
300 Rem Set interrupt control register
310 input n :@%b811=n
330 goto 140
500 Rem Read Interrupt Status Register
510 print hex (@%b810)
520 goto 140
600 Rem Check Interrupt Line
605 p=@%C000
610 if AND(p,%80)=0 then 140
620 print "I"
630 goto 200
1000 Rem Time Set Subroutine
1005 "Enter date. Preceed entries with %"
1010 "Month (1-12) ";:input g
1020 "Day of the month (1-31) ";:input h
1030 "Day of the week (1-7) ";:input i
1040 "Hour (1-24) ";:input j
1050 "Minute (0-59) ";:input k
1060 "Press SPACE to start clock"
1070 if @240=160 then 1090
1080 goto 1070
1090 @a=g:@b=h:@c=i:@d=j:@e=k
1100 goto 1200
1200 REM print full time parameters
1210 goto 1220+@c
1221 "Sunday ";:goto 1250
1222 "Monday ";:goto 1250
1223 "Tuesday ";:goto 1250
1224 "Wednesday ";:goto 1250
1225 "Thursday ";:goto 1250
1226 "Friday ";:goto 1250
1227 "Saturday ";:goto 1250
1250 if @a>9 then goto 1259+@a-6
1255 goto 1259+@a
1259 goto 1260
1260 "  January  ";:goto 1280
1261 "  February  ";:goto 1280
1262 "  March  ";:goto 1280
```

Listing 1 continued on page 56

Listing 1 continued:

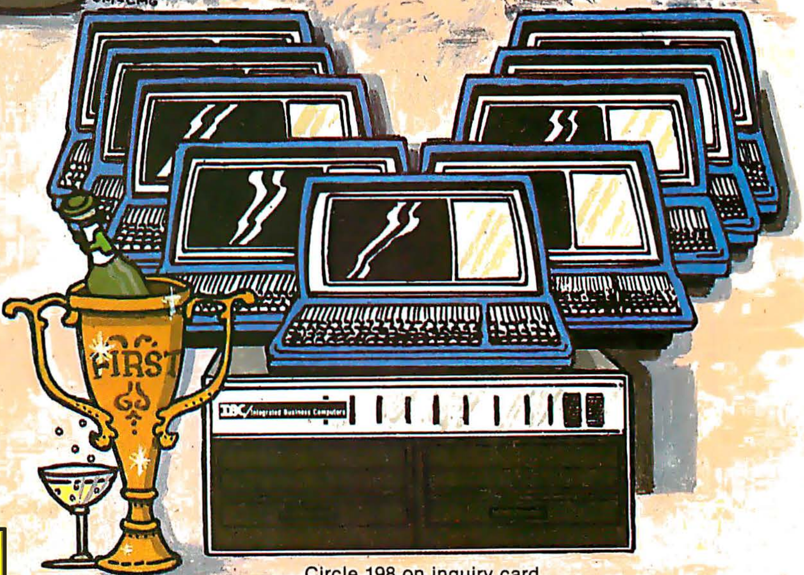
```
1263 "   April   ";:goto 1280
1264 "   May   ";:goto 1280
1265 "   June   ":goto 1280
1266 "   July   ";:goto 1280
1267 "   August   ";:goto 1280
1268 "   September   ";:goto 1280
1269 "   October   ";:goto 1280
1270 "   November   ";:goto 1280
1271 "   December   ";:goto 1280
1280 print Hex(@b)
1290 print hex(@d);" HOURS ";hex(@e);" MINUTES ";hex(@f);" SECONDS"
1295 goto 140
1300 print hex(@d);":";hex(@e);":";hex(@f)
1310 goto 140
```

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!	Indicates command-sequence initiation (all control commands must be preceded by "!").
Control-I	Set Interrupt Control register. Clock responds with "?". Remote computer sends "%X" and a carriage return (X is the BCD value computed according to figure 7). Each time the interrupt is triggered by a counter rollover, the clock will send "I" and a carriage return to the remote computer.
Control-R	Reset Interrupt Output.
Control-S	Set complete time parameters. This is the manual preset mode and is most easily set using a terminal off line as previously described.
Control-T	Send short time. Clock responds with hours, minutes, and seconds as "10:25:35" plus a carriage return.
Control-U	Read Interrupt Status register. Clock responds with the value stored in the Interrupt Status register. Reading this register resets the Interrupt Output.

Table 3: *Command codes used by the BASIC/Debug code in listing 1 to control the real-time-clock circuit of figure 6 from a remote computer. These codes were arbitrarily chosen and do not provide for activating all the capabilities of the MM58167A.*

The serial communication of time information to the remote computer is commanded by various control codes. Only the minimal required information is transmitted from the intelligent clock so that the information can be more easily used in an application program on the remote machine. A simple response to a time query of "06:34" reduces processor data manipulation in the intelligent clock. The control codes I chose (arbitrarily) are listed in table 3.

My brief demonstration does not include setting the Standby Interrupt. It should be added for any serious use. Also, because this intelligent clock contains a versatile microcomputer, it can be programmed for any data rate or custom data format.

In Conclusion

Technology has come a long way from the days when real-time clocks were based on a heartbeat interrupt clocked from the power line. The MM58167A real-time clock is a well-thought-out design which truly meets the market demand. Applications that once demanded expensive hardware/software solutions are now satisfied by low-cost LSI hardware.

National Semiconductor has long had the reputation of being a leader in semiconductor innovation, and I believe the company has justified that reputation with the MM58167A.

Next Month:

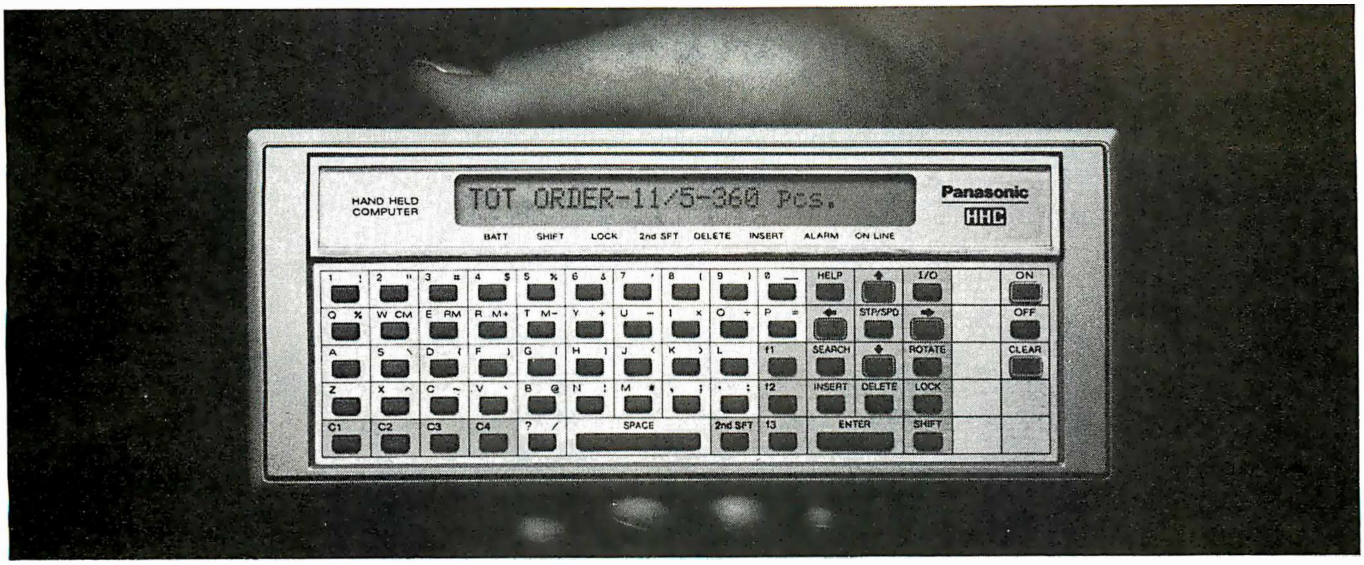
The high technology of video-image storage has been promising to benefit the computer industry. In June, I'll let you in on how to reap this benefit with a computer controller for the Pioneer VP-1000 Laserdisc video player. ■

References

1. Ciarcia, Steve. "Anyone Know the Real Time?", August 1979 BYTE, page 50. Reprinted in *Ciarcia's Circuit Cellar, Volume II.* Peterborough, NH: BYTE Books, 1981, page 96.
2. Ciarcia, Steve. "Build a Z8-Based Control Computer with BASIC, Part 1," July 1981 BYTE, page 38. Reprinted in *Ciarcia's Circuit Cellar, Volume III.* Peterborough, NH: BYTE Books, 1982, page 146.
3. Ciarcia, Steve. "Build a Z8-Based Control Computer with BASIC, Part 2," August 1981 BYTE, page 50. Reprinted in *Ciarcia's Circuit Cellar, Volume III*, page 156.

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, 70 Main St., Peterborough, NH 03458.* Ciarcia Circuit Cellar, Volume I, *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II, *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III, *contains the articles that were published from July 1980 through December 1981.*

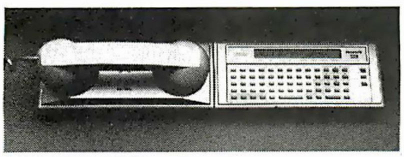
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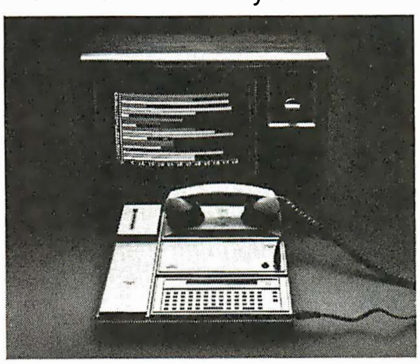
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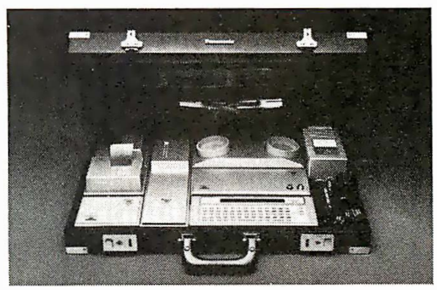


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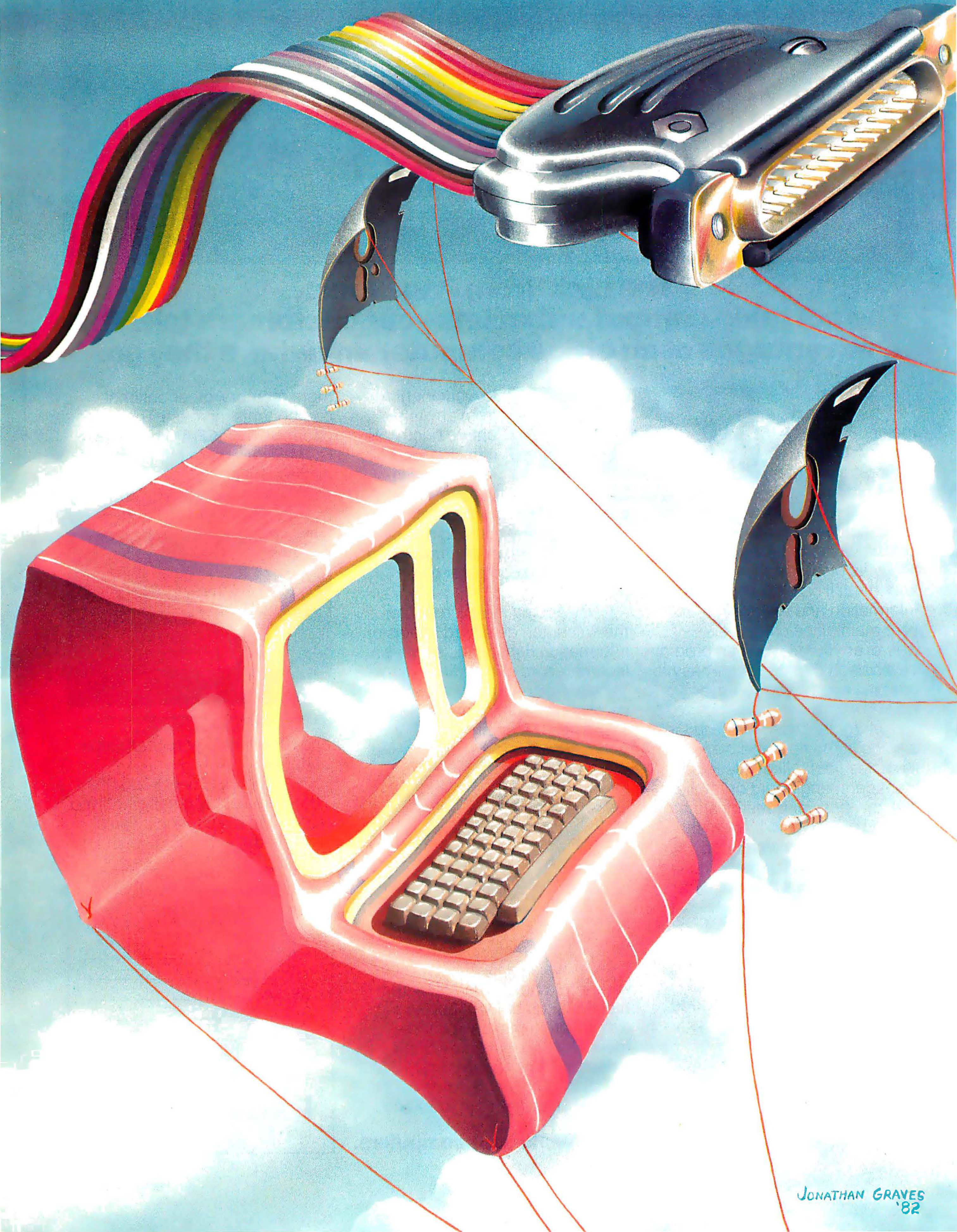
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Japanese Computers



Six Personal Computers from Japan

A comparative review of the BMC if800, the Canon CX-1, the Hitachi MB-6890, the NEC PC-8001A, the Fujitsu FM-8, and the Systems Formulate Corporation Bubcom80

Christopher P. Kocher
4233 Baltimore Ave.
Philadelphia, PA 19104

Michael Keith
D-46 Abbington Dr.
Hightstown, NJ 08520

Do you want a Japanese computer? Before you answer too hastily, think back a few years.

The trend setters who bought Toyota automobiles when they first appeared in the United States in the late 1960s got a great deal of bemused attention from their neighbors. The neighbors maundered about spare parts, Detroit styling, and horsepower, but the Toyota owners just smiled. They knew they were getting a low-cost car that was reliable and met their needs at a time when the domestic companies did not care to address that particular set of needs.

Today, of course, American motorists rush to buy Japanese cars while Detroit automakers, scratching their heads and wondering what went wrong, scramble to imitate the virtues of the Japanese imports. And in other industries in which Americans have heretofore led the world, pundits and xenophobes alike are stridently warning, "The Japanese'll getcha if ya don't watch out!" Many steel companies and electronics firms are beginning to feel the uncomfortable heat of Japanese competition.

What about personal computers? A few Japanese firms have started selling "Americanized" versions of their computers, and a few others plan to start. Will the Japanese take over again?

Our crystal ball is no better than anyone else's, but we would like to help you decide for yourself. In this article, we evaluate and compare six Japanese personal computers: the BMC if800, the Canon CX-1, the Fujitsu FM-8, the Hitachi MB-6890, the NEC PC-8001A, and the Systems Formulate Corporation Bubcom80. Some of them are already being sold here; some are in the process of being adapted for the American market; and some may never be sold here.

Of course, there is no one best computer, just as there is no single typical computer user. Each computer represents a design team's attempt to assemble a set of features that will appeal to a variety of users. How you rank a computer depends very much on what you plan to do with it. We will try to give as complete a picture of each machine as we can; you must supply the ranking.

Since the computers examined here are in various stages of adaptation, it would not be fair to rate the documentation of all the machines on the same scale. While some machines came with complete instruction manuals in English, others came with instructions written only in Japanese or with what were obviously first drafts of translations.

Moreover, since we had a limited time in which to examine a large number of very complicated machines, we had to concentrate on what is most salient: features that are conspicuously excellent, egregiously awful, or strikingly unique. We undoubtedly missed many subtleties of each machine. If this gives a misleading picture of any computer, we apologize.



Photo 1: *The BMC if800 computer. Shown here is the basic machine consisting of a keyboard/processor module, two floppy-disk drives, a color video monitor, and a unique built-in printer. Notice the 10 "super-function" keys along the bottom of the display screen. These are fully programmable function keys that can be used for menu selection or other forms of interaction in programs.*

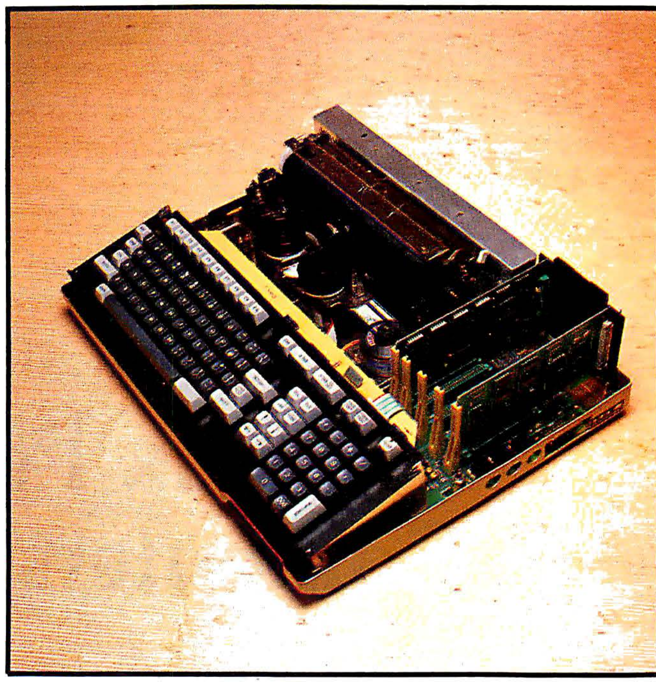


Photo 2: *Inside the keyboard unit of the if800. The built-in printer mechanism is clearly visible. The printer can operate as either friction-feed or tractor-feed, and produces a high-quality dot-matrix output.*

Photographs accompanying this article, except photo 6, were taken by Paul Avis, photographer, and Pauline Elkin, stylist.

BMC if800

The prize for the most computer in the smallest package goes to the if800 Model 20 computer, manufactured by the Oki Electric Company of Japan. But since it is marketed in this country by BMC Computer Corporation (which has its office in Carson, California—the abbreviation stands for Business Machines Corporation), we refer to it as a BMC product to avoid confusion. Although it is billed as a personal computer, it will receive much consideration as a small-business computer because it has high-resolution color graphics, support for Digital Research's CP/M operating system, a built-in printer and floppy-disk drives, and a very high-level BASIC language all as standard equipment.

Hardware Overview

The basic if800, shown in photo 1, consists of two pieces, one mounted above the other. One module contains the processor circuitry, the keyboard, and the printer; the other module contains the video-display screen and two 5¼-inch floppy-disk drives. The two modules are connected by two cables, one for the monitor and one for the disk drives. The combined system is sufficiently compact to fit well on even the most crowded table.

Keyboard

The 98-key keyboard is very solid and has a nice typing feel. In addition to tactile feedback, you receive audio feedback with every key depression in the form of a faint click from the speaker under the keyboard. If a key is held down for more than a second, it automatically repeats the typing of its character, along with audio feedback.

The 98 keys are separated into several groups: a typewriter-keyboard section, 10 program-assignable function keys, 8 editing keys, a numeric keypad, and several special keys. The special keys include keys for setting tabs, a CAN (cancel) key (which erases the line currently being typed), and three keys for controlling the printer. The typewriter section also has a GRAPH key (for accessing a set of special graphics characters, such as card symbols and line-drawing characters) and a COMD

At a Glance

Name
BMC if800 (Model 20)

Distributor
BMC Computer Corporation
860 East Walnut St.
Carson, CA 90746
(213) 323-2600

Dimensions (inches)
19⅞ by 20 by 26⅝

Microprocessor
Z80, 8-bit

Size of User Memory
64K bytes

Number of Keys
98

Number of Function Keys
20

Built-In Hardware
Dot-matrix printer; two 5¼-inch floppy-disk drives; color video monitor

Standard Interfaces
RS-232C (DB-25); light pen; monochrome video monitor; RGB color monitor; audio-cassette tape

Optional Interfaces
8-inch floppy-disk drives; parallel I/O port; IEEE-488 bus; A/D, D/A converters

Expansion Sockets
3

Character Sets
Roman, katakana, graphics

Graphics/Color Resolution
640 by 200

Number of Colors
8

Other Features
Time-of-day clock with battery; speaker with music sublanguage

Price
$7950 (whole system)

key that allows single-keystroke access to various BASIC keywords.

When the PRINT key is depressed, everything that appears on the display screen is printed by the built-in printer. A small LED (light-emitting diode) on the keytop indicates whether the computer is in print mode. For example, to get a program listing, merely hit the PRINT key, type LIST, and hit RETURN, and you have instant hard copy. A separate HARD COPY key can be used to dump the current screen image (text and/or graphics) to the printer.

It also has a KANA key, which the manual says allows access to Japanese katakana characters. However, in the American unit, the key has been disabled with a metal spacer. (See the text box "Japanese Character Sets.")

Built-in Printer

The if800's self-contained printer is conveniently placed behind the keyboard so that the paper comes out in the same direction as it does in an ordinary typewriter. The dot-matrix printer uses a wire-impact mechanism and a regular typewriter ribbon, and has both friction- and tractor-feed mechanisms. Its printing speed is 80 cps (characters per second), and the print quality is excellent (almost good enough to conceal the dot-matrix printing method). The only shortcoming we noticed is that in dumping a screen image (as opposed to regular character-by-character text printing) the scan lines are spread quite far apart in the printed image, making text or detailed graphics difficult to read. We hope this is only a software limitation.

What's Inside?

Photo 2 gives an inside view of the keyboard/processor module, where various components of the computer are visible. The cover lifts off easily for access to the insides. The keyboard sits on top of the main printed-circuit board, which contains the microprocessor (a Z80A running at 4 megahertz [MHz]), memory, and support circuitry, as well as a small speaker for audio output. The keyboard assembly is all metal, providing a degree of electromagnetic shielding for the main circuit board.

Also inside the case is a real-time-clock chip that can be read by software. We were surprised at one feature of the time-of-day clock: the first time we plugged in the if800 and ran

Japanese Character Sets

Japanese, unlike most languages, has four separate writing systems, and it is not unusual to see all of them on one page.

Kanji *characters are pictographs taken from Chinese. One character represents one word or concept. Kanji characters are used to represent roots of nouns or verbs.*

The hiragana *and* katakana *systems are syllabaries in which one character represents one consonant-vowel pair. Hiragana characters, full of graceful but tiny curlicues, are considered easier to read and are used in most text to indicate inflectional endings and to spell out words that are uniquely Japanese. Katakana characters represent exactly the same syllables as the hiragana but are more angular. They are used for children's books, official documents, and transliterating foreign words, especially foreign technical terms.*

The Roman alphabet is used for such things as computer commands, in large part due to the ubiquity of Western computer-language systems.

Most of the Japanese personal computers reviewed here offer a Roman-alphabet keyboard with some sort of locking shift key that allows the same keys to be used for katakana as well. Generally, a few very common kanji characters are thrown in as graphics keys (the pictographs for "date" and "time," for example), but the hiragana characters require resolution beyond the capability of most noninterlaced video displays.

If you think about it, the Japanese character sets might explain much of the feverish technological development in certain segments of the Japanese electronics industry—like the work on very dense read-only memories. The Japanese require great amounts of memory just in character generators to form the complex kanji characters.

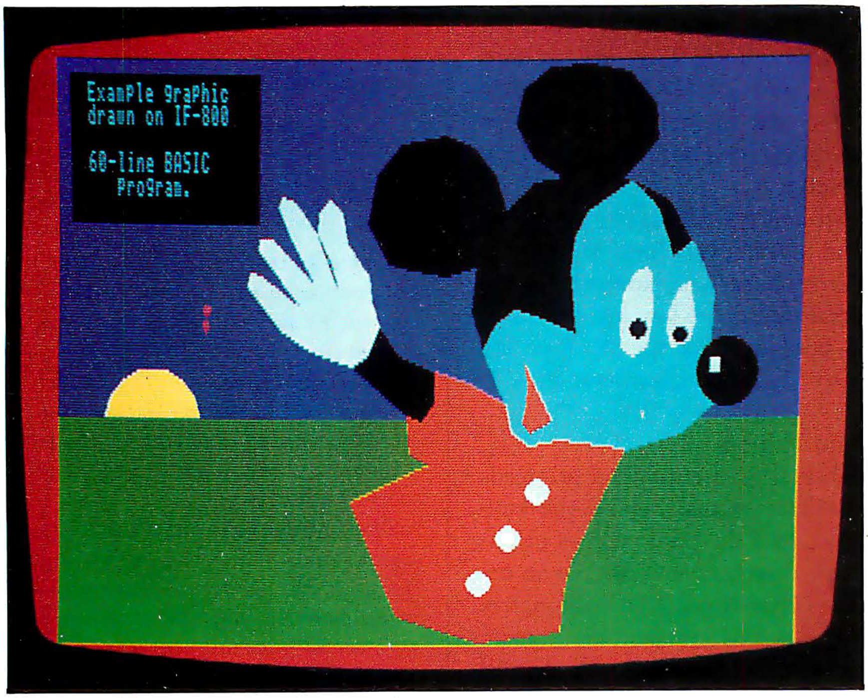


Photo 3: *A sample display from the if800, illustrating some of the graphics primitive operators. Most of the picture was produced using LINE commands to draw polygonal outlines followed by PAINT commands to fill the polygons.*

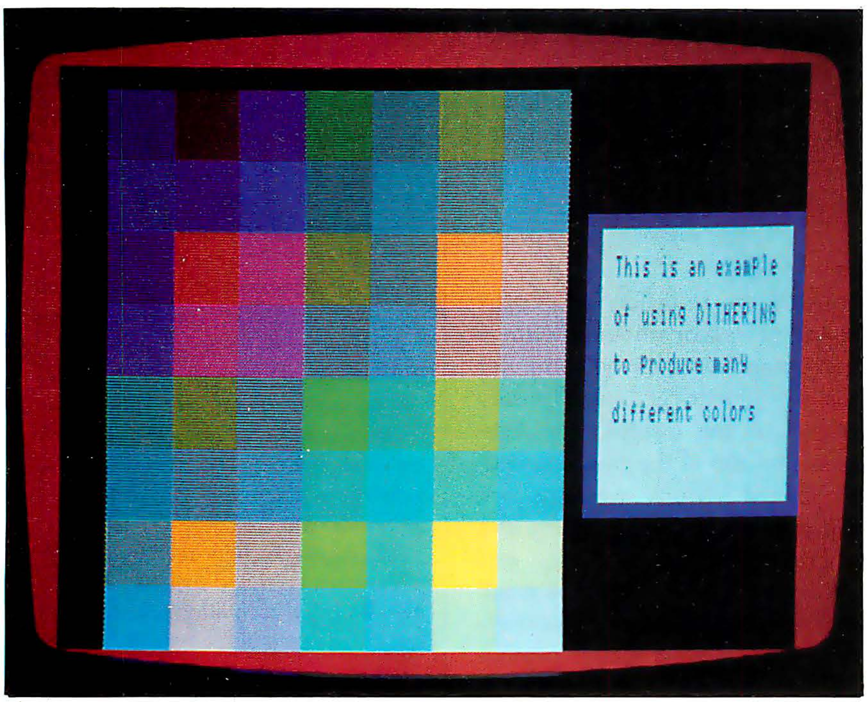


Photo 4: *An example of "dithering" on the if800. Even though only eight colors are available, by juxtaposing dots of different colors in different combinations, many different, apparently solid, colors can be displayed. This technique can also be used on the Fujitsu and Bubcom computers.*

one of the demonstration programs, the system showed the correct time! A little hunting inside the unit revealed a nickel-cadmium battery that keeps the clock chip going when the computer is unplugged or turned off.

Connecting to the World

Near the rear of the keyboard/processor module are five slots for peripheral-device-controller circuit cards. Two of these slots are occupied by controller cards for the color video display and the two floppy-disk drives. Many other optional interfaces are available, including a controller for 8-inch floppy-disk drives, a Centronics-compatible parallel printer port, an IEEE-488 interface (an Institute of Electrical and Electronics Engineers standard connection scheme), A/D (analog-to-digital) and D/A (digital-to-analog) converters, and additional RS-232C serial I/O (input/output) ports.

The keyboard/processor module has other switches and connection points. Built into its right side are a DB-25S connector for RS-232C serial communication and DIN (Deutsche Industrie Norm) connectors for a light pen, a black-and-white composite-video monitor, and an audio-cassette recorder. On the left side are two push-button switches that reset the system. The first button, labeled IPL (Initial Program Loader), is a "hard" reset that restarts the system in its power-up state, whereas the second button, NMI (Non-Maskable Interrupt), is a "soft" reset that returns you to the BASIC or CP/M command level (if possible). The NMI button is useful for aborting execution of a program in an infinite loop or some other "hung" state (when Control-C may not work).

Display Module

The top module of the if800 houses the standard color video monitor, which provides a high-resolution (640 dots horizontally by 200 dots vertically) eight-color display. Characters can be displayed in two sizes and in various screen formats (80 or 40 characters by 20 or 25 rows).

A unique feature of the if800 is the group of 10 "super-function" keys that are located on the video-monitor module, just below the display screen. These 10 keys duplicate the functions of the 10 function keys on the keyboard. Thus, they can be used under program control to produce any desired response. Their location makes it easy for an inexperienced user to select an item from a menu simply by pressing the function key just below the item shown on the screen. This would be especially useful in combination with a light pen because a program could be written that never required you to type on the main keyboard. You would just have to use the super-function keys.

Just to the right of the display screen are the two 5¼-inch two-sided double-density floppy-disk drives. Each floppy disk can store 280k (280,000) bytes.

Overview of Software

The two major software packages that came with our if800 computer were Oki BASIC, a Microsoft product, and a version of the CP/M operating system. In addition, several demonstration programs that run under each were provided.

Oki BASIC is a very high-level implementation of the BASIC language that fully exploits the hardware of the if800. For example, many of the special functions on the keyboard (such as TAB, DEL [delete], CAN, and the function keys) are supported, as well as the COMD key, which allows single-keystroke typing of commonly used BASIC commands. Most of the peripheral devices can be directly controlled from BASIC, including both disk drives, the printer, the onboard speaker, the light pen, the clock and calendar, and RS-232C ports.

Each peripheral device is supported by a whole array of BASIC keywords. An example of a device-control keyword is ON COM GOSUB, which allows a program to be interrupted by data arriving at the RS-232C port. A subroutine call is performed when a signal is detected on the port. This in effect allows for interrupt processing—usually reserved for assembly-language programmers—entirely within BASIC.

Displaying Graphics

Because the if800 contains a high-resolution color display, you might expect good graphics support from BASIC. We were not disappointed; many high-level keywords are available for manipulating the graphics screen. Primitive operators for drawing are available for creating images, including CIRCLE, LINE (which includes the capability of drawing rectangles), and POINT. In addition, a graphics macroinstruction facility called GML (Graphics Macro Language) is built into Oki BASIC. This is used by defining a BASIC character string consisting of GML commands, which appear mostly as a single letter followed by a single numeral. Typical GML commands are:

Each computer represents a design team's attempt to assemble a set of features that will appeal to a variety of users.

U*n*—Move cursor up *n* pixels (there are corresponding commands for other directions)
C*n*—Set color to *n*
S*n*—Set scale factor to *n*
X*string*—Execute a previously defined GML string

To execute a GML command, the statement DRAW *string* or *string-variable* is issued. One GML string can call another GML string, thus providing a nested-macro facility. Consequently, small detailed objects (such as game pieces or special symbols) can be compactly described and drawn with a single command.

Another facility for describing detailed graphics images is the DEF CHR$ statement in BASIC, which redefines any of the characters in the character set. Note, however, that characters can be only two colors (foreground and background), whereas GML commands can draw images with multiple colors.

Another interesting BASIC keyword is PAINT. A PAINT statement fills in the area starting at specified Cartesian coordinates and bounded by a specified border color with a specified fill color. The area boundary can be any complex shape bounded by any color (which need not be the same as the drawing color). If the boundary is very large and complex, an OUT OF MEMORY error may result, since a recursive algorithm utilizing a stack is used to process a PAINT command. This command, combined with the geometric commands, can be used to easily create graphics displays using filled polygons. A sample picture drawn by one of the authors is shown in photo 3. This was drawn entirely by a small BASIC program (containing a lot of DATA statements!).

The high horizontal resolution (640 dots across) allows use of a standard trick in computer graphics that can effectively provide many more than eight colors. This technique is called *dithering* and depends on the following effect: if we draw a horizontal line consisting of alternating blue and red pixels, our eyes will area-average the pixels and perceive the line as a solid line of a color somewhere between blue and red. By using different combinations and mixtures of the eight available colors, a whole array of different, apparently solid, colors can be displayed. Photo 4 shows a display created using this technique. Unfortunately, the BASIC PAINT keyword does not support filling with dither patterns, but someone will eventually write such a routine for the if800. Even more impressive graphics will then be possible.

The eight-color display can be thought of as three overlaid planes of red, green, and blue pixels. It is possi-

ble in software to choose whether one or several of these planes are to be displayed at any time. This could be used, for example, to allow superimposing a grid over an image in an architectural application program. The grid could be instantly displayed or removed at the touch of a key.

Musical Possibilities

A set of commands is also available for making single-voice musical melodies through the onboard speaker. Another sublanguage called MML (Music Macro Language) is used. A BASIC string is defined containing MML commands, which include commands for specifying pitches, octaves, timbres, and rests. To play the melody, the statement PLAY *string* is executed.

Minor Gripes

We noted only a few minor problems with the if800. When programming in BASIC, the keyboard produces uppercase letters in the normal mode. To get lowercase letters, the SHIFT key must be used. There is no shift-lock or lowercase-lock key, and there does not seem to be any way to reverse this behavior to the behavior most people expect (no shift=lowercase, shift=uppercase). This is fine for most programming, but if you have to type a lot of text (for example, in entering program instructions into the source file), it becomes annoying. The lowercase characters that have descenders are somewhat inelegant, as well; this is because of the small character matrix (8 by 8 dots).

Other Observations

In addition to Oki BASIC, we tested a 64K-byte version of CP/M. Since CP/M is widely known, we shall mention only a few unique features of the BMC version. First, a library of graphics routines that can be called from Microsoft's MBASIC is available. This allows utilizing most of the Oki BASIC graphics primitives (LINE, CIRCLE, PAINT, etc., but not GML commands) from MBASIC. In fact, the CP/M graphics library seems to execute these commands slightly faster than Oki BASIC.

A version of Wordstar, the popular word processor from Micropro International, was also supplied. Overall it works quite well, with most of the special features (such as boldface, underlining, and text justification) supported by the if800's built-in printer. Features not supported include multiple text sizes and proportional spacing, since the if800 printer cannot perform these functions. Also of interest is the fact that Micropro is said to be working on a color version for the if800, which will utilize the color capability of the video display.

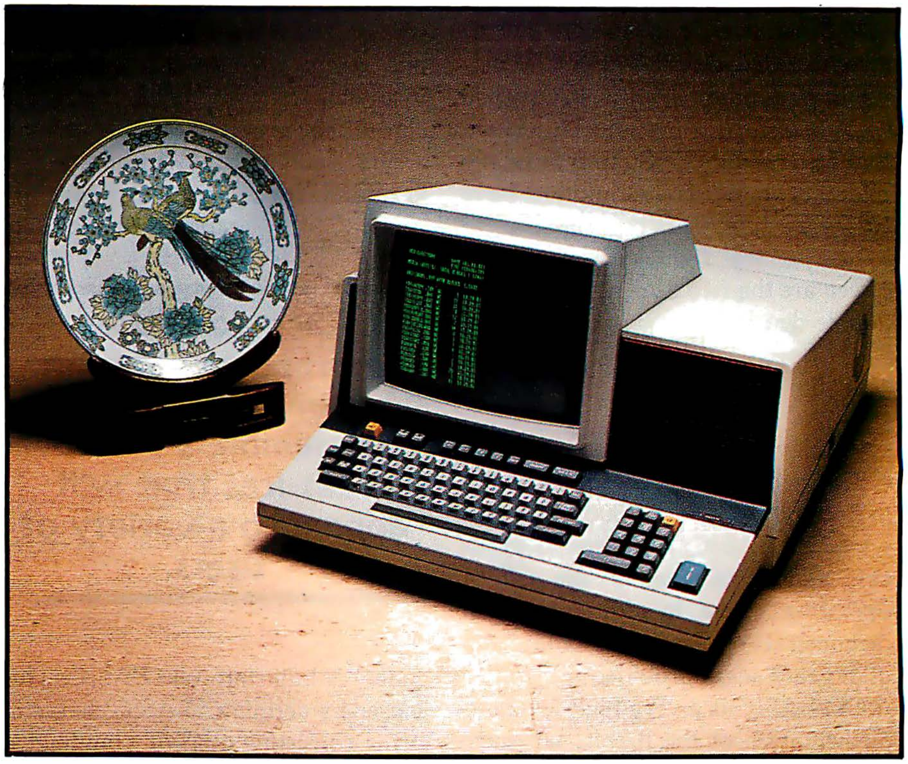


Photo 5: *The Canon CX-1 computer. All the parts of the basic machine (keyboard, processor, two disk drives, and green video-display screen) are contained within a single molded plastic case.*

Canon CX-1

The CX-1 computer is being presented in the marketplace mainly as a business computer, partly because of its one-piece construction and its monochrome green display screen, which make it quite at home in an office setting. The documentation is well suited for use by inexperienced office workers. It is being marketed in this country by Canon U.S.A. Inc., which has its main office in Lake Success, New York.

Hardware Overview

The basic parts of the CX-1 computer—the keyboard, processor, memory, video display, and two floppy-disk drives—are housed in a single cabinet measuring 53 by 64 by 33 cm (21 by 25 by 13 inches), shown in photo 5. This single-piece design has both advantages and disadvantages. An advantage is that there are no connecting cables to break or wear out. A disadvantage is that the unit

takes up a lot of desk space and is quite heavy; it weighs 25 kg (55 pounds).

Keyboard Characteristics

The CX-1's keyboard has 84 keys. In addition to the normal typewriter keys, it includes a numeric keypad, several command keys (SHIFT LOCK, UC, CTRL [Control], CAN, and ESC [Escape]), several editing keys (four cursor-control arrows, HOME, INS [insert], and DEL), two mode-select keys (PROG and OPE), and a HLT (halt) key.

Among the command keys are both a SHIFT LOCK key (which acts like a typewriter shift lock in that both alphabetic and numeric/symbol keys are locked in the shifted position) and a UC key (for "uppercase," which shift-locks only the alphabetic keys). The unfamiliar mode-select keys are used when programming in BASIC to switch between programming and operating modes (this will be explained later).

The HLT key is used to put the computer into a "pause" state. The computer will suspend whatever it is doing and display a special prompt character to show that it is in the pause state. You can then either continue or abort the current process. If this is done during execution of a BASIC program, variables can be examined in the pause state. This is very useful for debugging programs.

Another unfamiliar key is the large one labeled START on the right side of the keyboard. This key usually seems to work just like the RETURN key. It is labeled START because of the feature of Canon's BASIC interpreter that allows you to run a program by just hitting START in the "OPE" mode (rather than having to type "RUN" and then hit the RETURN key).

One notable omission from the keyboard is a REPEAT key (or a provision for automatic repetition of characters from all the keys). This is especially annoying when you are using the cursor-movement keys, as in editing; you have to keep jabbing away at the keyboard to keep the cursor moving. A REPEAT key would eliminate much of this tedium.

Other Hardware Features

The 12-inch green monochrome video-display screen sits over the keyboard. The display format is 24 rows

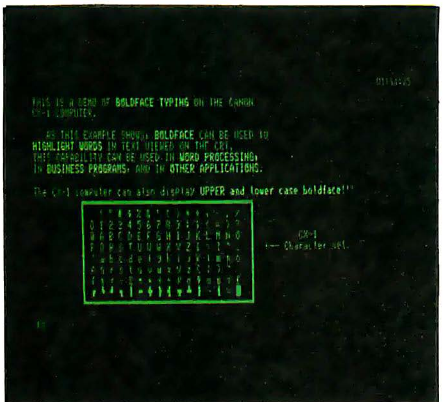


Photo 6: *The CX-1 display, showing the dual-intensity (or "boldface") capability. Characters can be displayed in two different intensities on the CRT (cathode-ray tube). Also, notice the clock display in the upper right-hand corner. This display (which can be either real time or elapsed time from some event) is automatically refreshed every second by the operating system. Photo by the authors.*

of 80 characters, and the overall display quality is excellent. One rare feature of the CX-1 is its ability to display characters on the screen in two different levels of brightness (sort of an electronic boldface). Photo 6 shows an example of this dual-intensity display, along with the complete character set. The CX-1 is an entirely character-oriented machine; these characters are all that can be displayed on the screen. There are no user-definable characters or any mechanism for displaying bit-mapped graphics.

A unique feature of the CX-1 is a constant display of the time from the internal time-of-day clock; this always appears in the upper right-hand corner of the video screen.

To the right of the screen are two 5¼-inch floppy-disk drives. Each one has a capacity of 320k bytes per disk. The operating system has a software door-lock function that prevents an absentminded user from opening the drive doors when the read/write head is engaged.

In the rear of the case are jacks for two optional additional disk drives, an optional light pen, three RS-232C serial ports, and three Centronics-compatible parallel ports.

Software: Operating System

The Canon computer is built around an 8-bit 6809 microprocessor and runs an operating system called MCX ("Monitor program for CX-1"), which is both powerful and unconventional. It is a very "mode-oriented" system; that is, you perceive the system as operating in various modes, each identified by a different prompt character. Operating modes, and their prompt characters, include:

0> MCX command mode
$ BASIC operating mode
% BASIC programming mode
@ Pause mode
. Editor

You can switch modes by various commands or keystrokes. Commands are not always obvious or consistent, however. For example, to switch from BASIC programming mode to operating mode, you must press the OPE key (whereupon a small LED on the OPE key lights up). To switch back, however, you must press PROG and then hit the RETURN key.

Another unconventional characteristic of the MCX operating system is that all user typing appears on the bottom two lines of the screen. Therefore it has no screen editing, and even the method of entering and editing a BASIC program takes some getting used to. When a BASIC statement is entered, it first appears on the twenty-third line of the screen, near the bottom. When the RETURN key is typed, the statement jumps to the

At a Glance

Name
Canon CX-1

Distributor
Canon U.S.A. Inc.
One Canon Plaza
Lake Success, NY 11042
(516) 488-6700

Dimensions (inches)
13 by 20⅞ by 25⅛

Microprocessor
6809, 8-bit

Size of User Memory
64K bytes

Number of Keys
84

Number of Function Keys
0

Standard Interfaces
Light pen; RS-232C (DB-25); printer; more disks

Expansion Sockets
4

Character Sets
Roman, graphics, boldface

Graphics/Color Resolution
None

Number of Colors
2

Other Features
Alphanumeric line labels; other FORTRAN-like features in BASIC

Price
$4995 (whole system)

(1a)
FRC(*x*) = *x* mod 1 (i.e., the fractional part of *x*)
FIX(x,*n*) = value of *x* rounded off to *n* decimal places
MOD(x,*n*) = x MOD *n* (i.e., remainder when dividing *x* by *n*)
MAX(*x1*,*x2*,...,*xn*) Highest valued member of a set of numbers
MIN(*x1*,*x2*,...,*xn*) Lowest valued member of a set of numbers

(1b)

CX-1 Function	Microsoft Equivalent
ASC$	CHR$
CHR$	STR$
STR$	MID$

Table 1: *Handy arithmetic functions available under Canon CX-1 BASIC (1a), and string functions that are incompatibly named for conversion from Microsoft BASIC (1b).*

main part of the display and reappears at the correct place in the program. Similarly, to change a BASIC statement, you must first pull it down to the twenty-third line (via an editing command), edit it, and then reinsert it into the program.

MCX acts like CP/M in that when it encounters an unrecognized command, it searches the disk to try to find a BASIC or command file by that name to execute. The MCX operating system seems to read from and write to the system disk more frequently than most systems; this slows down the operation of many commands. We were surprised that the system accesses the disk during certain phases of operation—for instance, every time the BASIC program in memory is edited and run (the disk access comes after you type the RUN command).

The Canon CX-1's one-piece construction and its monochrome green display screen make it quite at home in an office setting.

Another feature of the MCX operating system is the SECURE command, which allows you to cause a BASIC program file on disk to assume the "secured" state. A secured file can only be executed, not listed. This provides a modicum of software protection, since it prevents unauthorized users from reading the source code. When a file is secured, a six-character password is requested. Only by correctly reiterating this password can a file be unsecured.

Software: BASIC Interpreter

The most important subsystem of MCX is Canon CX-1 BASIC. This interesting dialect of BASIC contains certain features seemingly borrowed from FORTRAN. This version of BASIC uses type declarations akin to those in FORTRAN, the double asterisk ("**") for exponentiation, FORMAT statements, and an interesting form of subprogram linkage. Perhaps the most attractive feature of CX-1 BASIC is its ability to use alphabetic labels for program lines. Here is a sample program in CX-1 BASIC:

```
10 FOR I=1 TO 100
20 N=N+I
30 IF N>2000 GOTO [FINIS]
40 NEXT I
50 [FINIS] PRINT I: END
```

Notice that each line still has a line number, as in ordinary BASIC, but it can also have a label in brackets after the line number. This label can be referenced in GOTO, GOSUB, and IF... GOTO statements.

Another unique feature of CX-1 BASIC is its CALL statement, which allows an executing BASIC program in memory to call a BASIC program on disk as a subroutine. Upon encountering a CALL, the operating system searches for and loads the called program into memory, executes it, and then returns control to

the original calling program. Values of variables can be passed between programs by declaring them with a PARAM statement in the called program. It is possible in this way to have many BASIC routines in memory at once (assuming they all fit, of course).

This powerful capability allows the programmer to write structured, modular programs. Libraries of commonly used Canon-BASIC routines can be developed and tested individually. These routines can then be used by other programs or executed sequentially to form new, more complex programs.

Also, it has a built-in XREF command, which provides a cross-reference listing of a BASIC program, listing all variables and the lines in which they occur. To our knowledge, this is the only BASIC interpreter that comes with this command built in.

CX-1 BASIC contains several unusual and useful functions, such as the arithmetic functions shown in table 1a. Two other unique keywords are SAVECRT% and LOADCRT%, which save and recall the current video-screen image as a 1920-byte disk record.

One last observation about CX-1 BASIC: some of the string functions have nonstandard names compared to almost all other versions of BASIC (certainly the Microsoft-derived varieties). Some examples of these are shown in table 1b. This can be quite confusing at first to an experienced BASIC user. It also complicates the conversion of programs to or from other versions of BASIC.

Other Software

In addition to the BASIC language, several other important subsystems of MCX come as standard equipment with the computer, including a line-oriented text editor (similar to the familiar ED of CP/M) and a 6809 assembler and debugger. Finally, it also has a text formatter called CROFF (Canon's version of Unix's NROFF?) that, unfortunately, we were not able to test.



Photo 7: *NEC's PC-8001A together with the color monitor, PC-8012 I/O unit, and PC-8032 dual floppy-disk drive.*

NEC PC-8001 A

The Nippon Electric Company (NEC) PC-8001A, shown in photo 7, is a version of the PC-8001 that has been adapted for the American market. (We previously reviewed the original unit as it was sold in Japan; see our article "The NEC PC-8001: A New Japanese Personal Computer," January 1981 BYTE, page 72.) As you would expect, there are few differences. To avoid duplication, we shall concentrate on those differences and on the floppy-disk drives and I/O chassis, which we did not review last time.

As closely as we can determine, the software for the PC-8001A is identical to that of the PC-8001—both run Version 1.1 of N-BASIC, written for NEC by Microsoft. (On the unit we tested, there was one galling difference: the cursor would not appear when the screen was in the 80- or 72-characters-per-line mode. An NEC spokesman, however, assured us that this was due to a defect in the unit we were testing and is not a characteristic of the system.)

Keyboard and Character Set

The katakana characters available on the PC-8001 display have been replaced by the Greek alphabet and a set of superscripts (see photo 8 on page 70). The keyboard, aside from the absence of kana legends on the keycaps, has only two differences. What was the Roman/katakana key

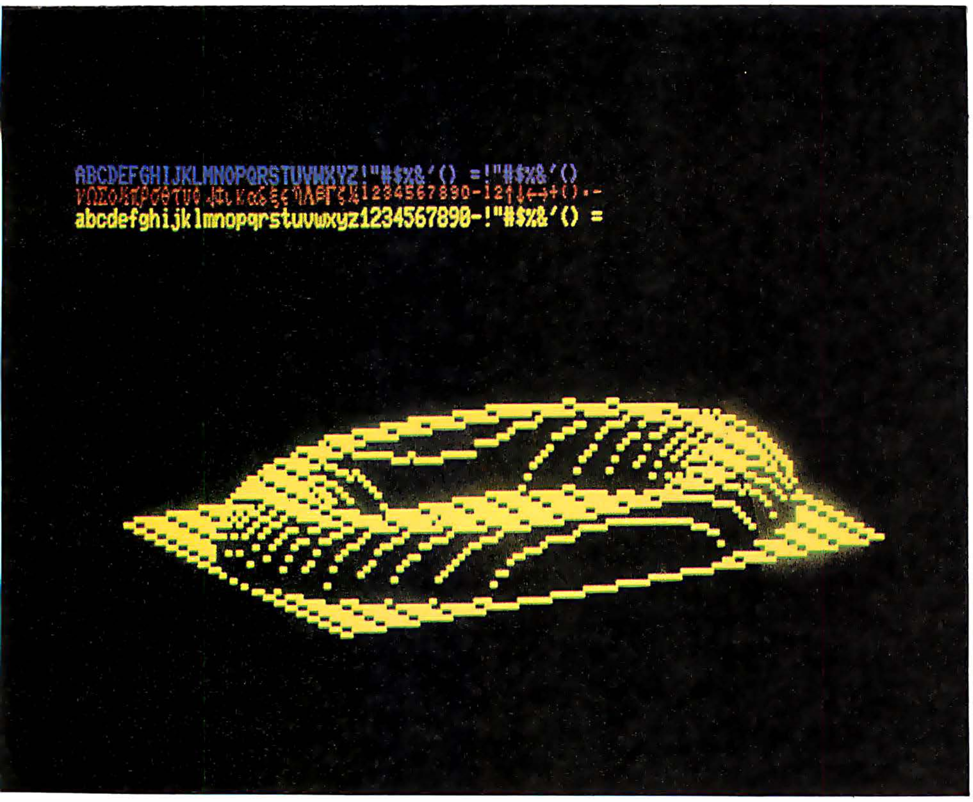


Photo 8: *The NEC display. Katakana characters in the Japanese version have been replaced by Greek characters and superscripts in the American version.*

At a Glance

Name
NEC PC-8001A

Distributor
NEC Information Systems Inc.
5 Militia Dr.
Lexington, MA 02173
(617) 862-3120

Dimensions (inches)
3¼ by 16⅞ by 11

Microprocessor
μPD780C-1 (8-bit, Z80-compatible)

Size of User Memory
32K bytes

Number of Keys
82

Number of Function Keys
5 (shift yields 10 functions)

Standard Interfaces
RS-232C; audio-cassette tape; monochrome video monitor; RGB color monitor; printer; expansion bus

Optional Interfaces
Floppy-disk drives; I/O chassis; communications subsystem (IBM 3270, 3780, and HASP protocols)

Expansion Sockets
1 (system bus)

Character Sets
Roman, Greek, superscripts, graphics

Graphics/Color Resolution
160 by 100; 80 by 25 (character-oriented)

Number of Colors
8

Other Features
Time-of-day clock; beeper

Prices
Keyboard/processor $995
RGB color monitor $995
Dual floppy-disk drive $995
I/O unit $649

on the 8001 is a much needed shift-lock key on the 8001A, and a duplicate "−" (minus) key in the 8001's numeric keypad has been replaced by a locking "alternate character set" (i.e., Greek and superscripts) key on the 8001A.

Unfortunately, neither the alternate character set nor the graphics character set are indicated by legends on the keycaps—this makes them extremely awkward to use. If you have forgotten which is the Greek "gamma" (γ) key, for example, you have to open the instruction manual, turn to the keyboard diagram, locate the gamma key, count the number of keys to the edge of the keyboard in the diagram, count the same number of keys in from the edge of the actual keyboard, and finally press the key. While most of the other computers reviewed here make you use this same sequence for graphic-character input, NEC forces you to do it for both graphics and Greek characters. Such a nuisance could and should be remedied, either by inscribing the alternative characters on the tops or fronts of the keys or by offering a set of stick-on labels for both alternative character sets.

What's Inside?

Inside the keyboard/processor module, we found only two differences between the Japanese and American versions. The American version has a thick metal cover over the main printed-circuit board. This cover protects and stiffens the board underneath, but it was probably added as a shield to help the PC-8001A meet the Federal Communications Commission's stringent RFI (radio-frequency interference) emission limits. Also, the American version has more memory, 32K bytes, as standard equipment. (Because part of this memory is used for the display, up to 26,786 bytes are available to the read-only-memory-based BASIC interpreter for program and data storage, while 19,367 bytes are available to the disk BASIC system.) The NEC μPD780C-1 microprocessor, which is

practically identical to the Zilog Z80, runs at 4 MHz.

Judging from our experience with the Japanese version, the hardware is quite reliable. We have used our PC-8001 both as a computer and as a terminal almost daily for over a year and a half with no trouble.

Our only quibbles have been relatively minor. One is the location of the Reset button, which extends from the rear of the console. It is easily triggered by accident if you push the keyboard against books or a wall at the back of your desk. We eventually remedied this minor problem by hanging a large hex nut on the protruding button. Our other quibble is the RS-232C serial interface—instead of a standard DB-25S connector on the outside of the case, NEC provides only a DIP (dual-inline pin) socket hidden away in a relatively inaccessible spot inside the case. NEC does sell an adapter cable with a DB-25, but the added expense should not be necessary.

The size of the NEC keyboard/processor module is attractively small: only 8.3 by 26 by 43 cm (3¼ by 10¼ by 16⅞ inches), hardly bigger than just the keyboard. It is light enough to hold on your lap while you type, and it can easily be shoved to the side of your desk top when it's not in use—a definite advantage if your desk is crowded and doesn't really have room for a computer. Moreover, like most of the Japanese computers reviewed here, it can serve double duty either as a computer or as a remote terminal for a larger system.

Peripherals and Expansion

Of course, such a small chassis has no room inside for expansion, but to many users that is unimportant. For those who do wish to expand their systems, NEC sells the PC-8012A I/O unit shown in photo 9, a box that contains a power supply, 32K bytes of RAM (random-access read/write memory), sockets for 2K bytes of PROM (programmable read-only memory), interrupt-control circuitry,

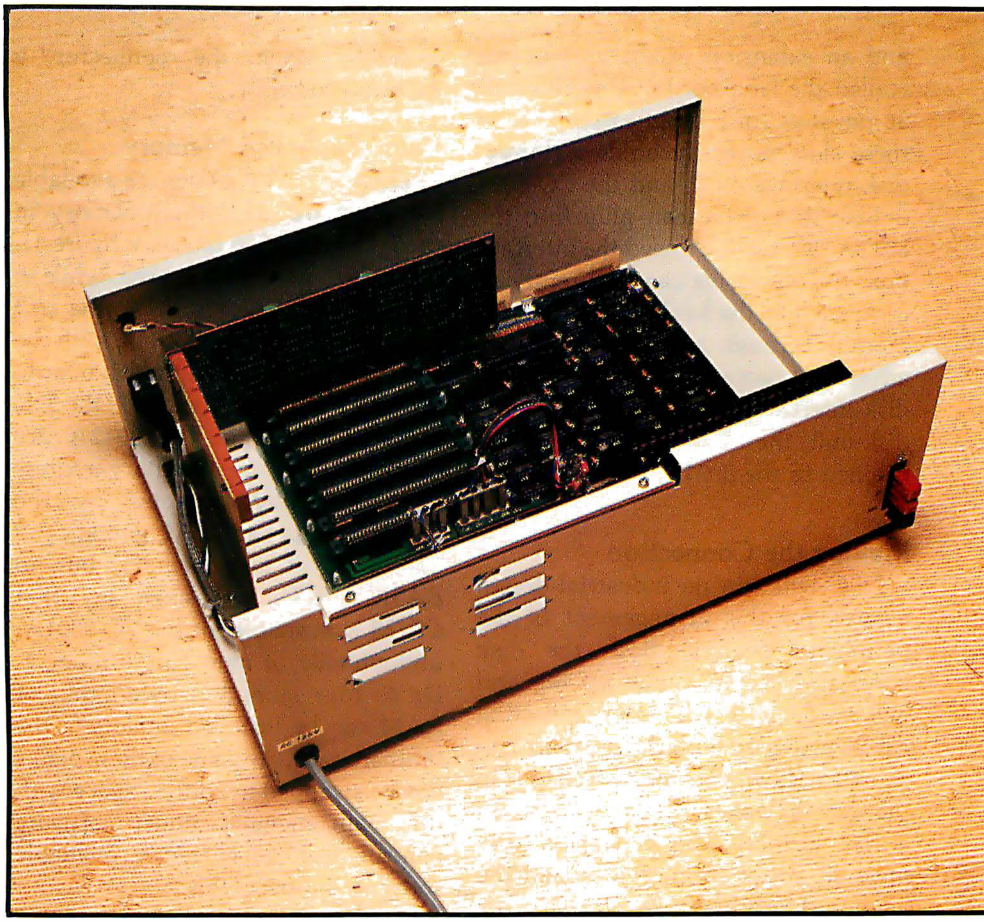


Photo 9: *The NEC PC-8012A I/O unit has seven slots for expansion and connectors on the back that can carry nonstandard voltages to the bus.*

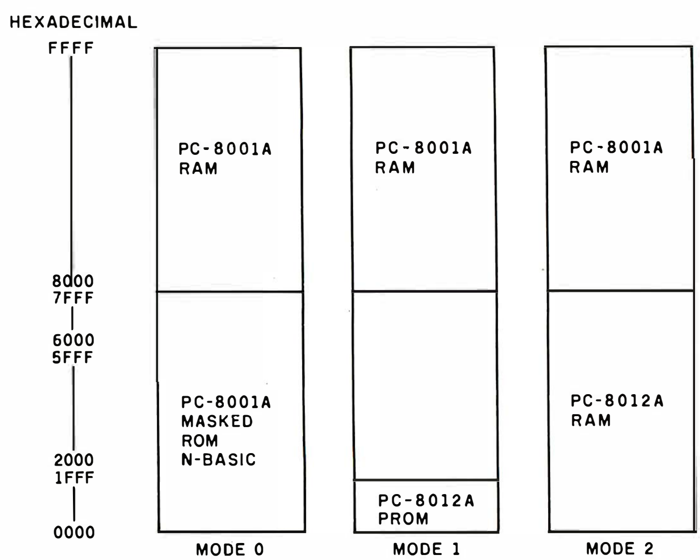


Figure 1: *The NEC PC-8001A can operate in any of three memory modes when the PC-8012A I/O unit is connected.*

and an extension of the system bus (called the "mother bus") with seven 36-pin slots for plug-in cards. One of these slots normally holds a floppy-disk interface card, and the PC-8031 double disk drive can plug into the 8012A. If you don't need the interface box, the disk drive can apparently be connected to the keyboard/processor module through another less widely advertised accessory, the PC-8033 disk-interface unit. A second double disk unit, the PC-8032, can be daisy-chained to the 8031.

Making the Connection

NEC will win no industrial-design awards for this arrangement of the peripheral devices. Both the disk drive and the I/O unit are big and awkward, and the interconnecting cables provided with the units are too short to allow you much freedom in the way the boxes can be arranged on a flat surface. The expansion unit *must* sit about six inches behind the keyboard/processor. By straining the cable a bit, you can place the disk drive to either side of the keyboard. The combination of short, wide peripherals and short cables largely negates the advantages of the 8001A's small size.

Nor has the cabling arrangement been designed with an inexperienced or inept user in mind. Instead of separate connectors mounted firmly to the chassis, slots located in the chassis give access to edge connectors on the printed-circuit boards. The boards are recessed and slightly flexible, and, since there is inevitably some play in their mountings, seating the connectors properly or unplugging them requires considerable fumbling.

Moreover, the connectors have not been "idiot-proofed"; they can be inserted upside down about as easily as they can be inserted right side up. Indeed, the disk-unit-to-I/O-unit (8031 to 8012A) cable almost begs to be inserted upside down—an arrow on the connector that is supposed to indicate proper orientation is printed on the bottom of the connector, where it is invisible when the connector is oriented correctly.

Using Expanded Memory

Three memory modes are available for using the additional memory in the I/O-expansion unit (see figure 1). In mode 0, none of it is used, while in mode 1, only the PROM in the I/O unit can be addressed, along with the 32K bytes of RAM in the keyboard/processor module. In mode 2, the 32K bytes of RAM in the 8012A are mapped into the memory-address space normally occupied by the BASIC-interpreter ROM, giving a full 64K bytes of user memory, but no BASIC. NEC spokesmen say that CP/M is available for the PC-8001A; undoubtedly, it must run in mode 2. Up to four more 32K-byte banks of RAM can be installed in slots in the motherboard. Any one of these banks can be swapped in address space with the main memory under software control, but no currently available software supports this.

Judging from our experience with the Japanese version, the hardware of the NEC PC-8001 is quite reliable.

Control-Line Versatility

The bus structure of the 8012 appears to be designed for either instrumentation or process control. It looks like it could be easily interfaced to the IEEE-488 bus. It has separate lines for eight levels of interrupts, and an 8214 interrupt-control chip is an integral part of the unit. Also included is a 600-hertz (Hz) real-time clock that can be used to generate an interrupt every 1.67 milliseconds (ms); during such an interval, the microprocessor could poll or service many more than eight devices.

In addition to the address, data, control, and interrupt lines, the system bus has six undefined lines, plus two sets of lines that can carry voltages input through a set of connectors at the rear of the chassis. These features make the bus particularly convenient to those wishing to build homebrew interfaces, even to systems requiring voltages other than the standard +5 volts (V) and ±12 V.

Floppy-Disk System

While, as we noted above, the dual floppy-disk drives take up a lot of real estate on your desk because they are mounted side by side, horizontally, they do hold a lot of data. The soft-sectored 5¼-inch disks are formatted for 256 bytes per sector, 16 sectors per track, with 35 tracks per disk (34 user-accessible), for a total of 139k bytes per disk, although the disk directory won't allow a lot of small files. The cabinet is made of the same sturdy metal as the 8012 I/O unit, and, in addition to the clasp that snaps the drive doors open and shut, each drive has a separate lever that can be used to lock it shut.

The disk-drive unit is also "intelligent"—a separate controller within the drive unit does some of the work associated with storing data on a disk; the unburdened main processor just passes data through an I/O port. This is probably the reason for the major peculiarity of the NEC disk-access software.

In most disk BASICs, you just slide a disk into drive number 2 and type LOAD "2:*filename*" and the file loads. If you try that with the PC-8001A, you will get the error message "Disk Not Mounted"—you must type MOUNT 2 before you can use the disk. When you are done with the data on the disk, you must similarly type REMOVE 2 before removing the disk; if you insert another disk in the same drive, you must MOUNT it as well. These commands are necessary because the microprocessor works with a copy of the disk's file-allocation table that it reads into user memory when it executes the MOUNT command. The disk's copy of this table is not updated until the

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REMOVE command is executed. If you forget to issue the REMOVE command, the manual warns, the interpreter will not be able to locate any of the files you have added during that session, and, in the worst case, all data on the disk will be lost.

Documentation

As we explained earlier, we have not mentioned documentation for most of the machines reviewed here. Because some of them have not yet been introduced into the U.S. market, many of the user's manuals we saw were either preliminary translations or in the original Japanese. But the NEC PC-8001A is already being sold here, and the documentation we saw was what a buyer would see. We therefore decided to mention the documentation briefly to reassure would-be buyers who fear that the instructions for their new, expensive, and complicated Japanese computer may be as mystifying as the instructions that come with a cheap made-in-Japan Christmas toy.

Although NEC's documentation is readable, in places it could be much better. The *PC-8012A I/O Unit User's Manual* would probably be somewhat mystifying to a totally inexperienced user because it seems to presuppose a good knowledge of both hardware and software. There are not enough step-by-step, do-this-then-do-that instructions; complicated features are inadequately explained; and some of the text is just plain bad English.

The *PC-8001A Microcomputer Reference Manual* is uneven in quality. Explanations of the BASIC commands are good, but they duplicate some sections of the NEC *BASIC Language Learning Guide* word for word. Explanations of more complicated hardware or system features, such as the terminal mode and the assembly-language monitor, tend to be confusing and poorly written. (One extreme example discusses the TM (test memory) command: "Note: As for the contents of the FF39 through FF3C numbers, since only under normal circumstances does TL *(sic)* memory of the FF39 - FF3C numbers become significant, after the TM command is entered in a situation in which an error occurs for a few seconds." Anyone find a verb there?)

Moreover, the English version leaves out a lot of valuable information included in the Japanese documentation, the *PC-8001 User's Manual.* Most conspicuously absent are the pinout tables for the printer interface, system bus, and RS-232C interface. The last is particularly noticeable because the RS-232C connector is a DIP socket and not a standard DB-25 connector.

On the other hand, the *PC-8031 Mini Disk Unit User's Manual* is pretty good, although it could be improved by the addition of some photographs of assembled systems. And NEC's *BASIC Language Learning Guide* is excellent—a well-planned and well-written primer with many examples and a set of self-test review exercises and answers at the end of each chapter.



Photo 10: *The Hitachi MB-6890 personal computer together with the color video display, double floppy-disk drive, and dot-matrix printer.*

Hitachi MB-6890

The word that best describes the Hitachi MB-6890, shown in photo 10, is *flexible.* It offers as standard equipment several features that other manufacturers provide only as expensive add-ons, such as a light-pen interface and an RS-232C interface complete with DB-25 connector. Also, it has such a profusion of hardware- and software-controllable switches and options that each user can configure the machine to individual taste.

Details of Construction

The case of the Hitachi processor unit is entirely plastic except for the detachable metal lid covering the rear. The rather thin (0.27-mm, 0.070-inch) base is reinforced with plastic posts in the rear where it is often required to bear the weight of the video monitor, and it is protected in front by the overlap of the substantially thicker plastic of the keyboard. This monocoque construction yields

Circle 426 on inquiry card. →

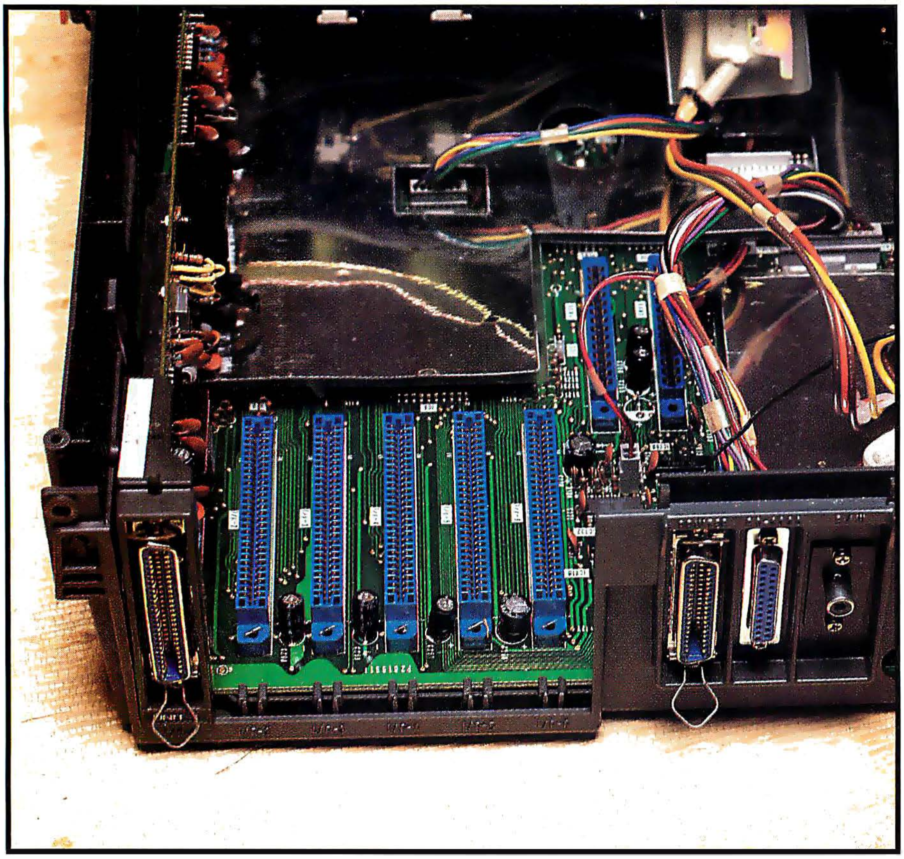


Photo 11: *Hitachi provides a set of individually removable panels along the back of the processor enclosure to give access to individual expansion slots on the motherboard.*

At a Glance

Name
Hitachi MB-6890

American Representative
Hitachi Sales Corporation
of America
401 West Artesia Blvd.
Compton, CA 90220
(213) 537-8383

Dimensions (Inches)
4¾ by 17⅞ by 20¼

Microprocessor
6809, 8-bit

Size of User Memory
32K bytes

Number of Keys
89

Number of Function Keys
5 (with shift gives 10 functions)

Standard Interfaces
RS-232C (DB-25); monochrome video monitor; RGB color monitor; audio-cassette tape; light pen; printer; game paddles

Optional Interfaces
Disk drives; extra printers

Expansion Sockets
6 for I/O; 2 for RAM

Character Sets
Roman, katakana, hiragana, graphics

Graphics/Color Resolution
640 by 200; 80 by 200

Number of Colors
8 on 8

Other Features
Time-of-day clock

Prices (Yen Equivalent in Dollars)
Keyboard/processor Y = $1035
Color monitor Y = $ 860
Disk drive Y = $1500
Printer Y = $ 763

a processor cabinet that is adequately strong and remarkably light.

The back of the case, shown in photo 11, shows Hitachi's solution to the problem of how to give access to optional peripheral-device circuit boards plugged into the system's bus. Six 56-pin sockets for edge connectors are mounted on the motherboard, perpendicular to the back of the case, and there is a removable plastic slot panel behind each socket.

The disk-controller board shown installed in the first slot incorporates a similar slot panel, mounted on the circuit card, that both stiffens the card and houses the card's connection to the outside world. Thus, no gaping holes are left for options that you may never install, nor must you arrange to snake expensive lengths of ribbon cable all over the inside of the processor cabinet to reach a fortuitous gap between sections of the case.

Since this plastic case provides no electromagnetic shielding, most of the motherboard and the circuit board underlying the keyboard are covered with thin (0.43-mm, 0.017-inch) sheets of aluminized plastic, making them look like hastily wrapped Christmas packages. Because this "gift wrapping" is staked in place and impedes access to the motherboard, it must surely also impede convective cooling of the electronic components underneath. On the other hand, it provides expensive components with an extra layer of protection against dust or an overturned mug of coffee.

System Versatility

The most striking features inside the case are the large number of miscellaneous unused connectors and a plethora of relocatable jumper connections. This suggests that it may be possible to substantially reconfigure the hardware rather easily.

In fact, a number of such reconfigurations are documented in the user's manual. Several of the jumpers have functions you might expect, such as setting the serial data-transfer rate and the transmission/reception parameters for the terminal mode.



Switch Number	Open	Closed
1	BASIC mode	Terminal mode
2	Interlaced screen	Noninterlaced screen
3	80 characters per line	40 characters per line
4	Normal mode	High-resolution mode
5	Function keys labeled	Function keys unlabeled
6	Half duplex when terminal	Full duplex when terminal
7	7 bits/char when terminal	8 bits/char when terminal
8	Hiragana converted to katakana for printer	Hiragana output to printer

Table 2: *Functions of the Hitachi state-selection switch.*



Photo 12: *The Hitachi BREAK key is protected by a transparent plastic clamshell. The KATA/HIRA key can change the machine between any of three states—the color of the LED beside it indicates the state.*

More unusual is an eight-position DIP switch on the motherboard that can be used to determine what state the machine will be in when the power is turned on (see table 2). Normally, the switch on the console labeled MODE is wired in parallel with DIP switch number 3, the characters-per-line switch. But by simply moving a jumper on the motherboard, it can be rewired to parallel DIP switches 1 or 2.

We should add that all these parameters can be reset individually by issuing the appropriate command from the keyboard, e.g., WIDTH 80 to select the 80-characters-per-line display mode. If you would rather change several of them simultaneously, you could reboot the system in the desired mode with the command NEW ON *b* where *b* is an expression with a value from 0 to 255, inclusive. The 8 bits of the binary representation of *b* serve the same purpose as the eight DIP switches; a 1 in the least significant bit (bit 1) corresponds to switch 1 being in the open position.

This is a fine idea, showing great insight into the wide variety of ways people use personal computers. It allows the person who uses the machine primarily as a remote terminal for a large system to turn the MB-6890 on and find a functioning terminal, rather than a computer that can be turned into a terminal only with a lengthy set of commands; it allows the person who wants both a computer and a terminal to configure a machine that switches from one use to the other with one push of a button; and it lets the person who primarily wants a stand-alone computer to find the machine in this form when it is turned on.

Keyboard

The keyboard, like that on the other computers reviewed here, has all the typewriter keys, plus a numeric/editing keypad and a set of user-definable function keys. Controls that are used infrequently (the on/off, reset, and mode-select switches, and a knob controlling the loudness of the click that accompanies each keystroke) are hidden behind a small door at the top of the keyboard. The BREAK key (a powerful stop/reset key) has a transparent plastic clamshell around its front edge (visible in photo 12), which prevents you from hitting it accidentally.

The keyboard has four cursor-control keys. The cursor-left and cursor-right keys have two separate modes of operation. Normally, they move the cursor in increments of one character position, but with the SHIFT key depressed, they move the cursor a word at a time.

Every time you hit a key, the speaker in the bottom of the keyboard/processor module produces a click. As we said, a knob adjusts the volume. The electronic clicks are





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completely inaudible when the knob is set for minimum volume, but the key hitting the mechanical stop at the bottom of its excursion still provides audible feedback. Thus, the only distinctive function served by these clicks is to indicate the repeated entries that occur when a key is held down for more than a half second. Nonetheless, the pitch and duration of beeps from the speaker may be controlled by an assembly-language program. Thus, the speaker can be used to produce sound effects and rudimentary music.

The MB-6890, like most microcomputers, uses a scanned keyboard; the keys are wired in a matrix, with each key capable of closing a connection between a horizontal (row) and vertical (column) electrical line. The keyboard-monitor circuitry detects closure of the switch inside the key by rapidly sending out pulses to successive columns while monitoring the row lines. An input sensed on row x while the output is going to row y indicates that the key at the intersection of x and y was pressed. Since the circuitry can typically complete a scanning cycle many times during the interval it takes a key to close and open again, it is unlikely to miss keys hit by even the fastest typist. Software in the keyboard monitor can aid in deciphering key "rollover," hitting a second key before the first is released.

But the MB-6890 keyboard, either through insufficient scanning speed or inadequate rollover software, does not accept key rollover very gracefully. The manual warns, "Be careful not to press more than three keys at the same time." This may seem an unlikely occurrence during text entry; whether it is or not depends on your skill as a typist, your typing speed, and the type of material you are entering. The problem is most apparent when you hold down the GRAPH key (to input either graphics or hiragana characters, depending on graphics mode) and rapidly type D followed by the adjacent key F. The computer often interprets it as a spurious cursor-up character, and the cursor goes bouncing merrily up to the previous line. Very disconcerting and very annoying!

Coping with Characters

The key labeled KATA/HIRA solves the problem of dealing with the four character sets used in Japanese text. Hitachi's elegant solution could easily be adapted to more universal problems. To understand its function, you must know that Japanese, unlike most languages, has four separate writing systems: kanji, katakana, hiragana, and the Roman alphabet. A brief discussion of the function of each appears in the text box "Japanese Character Sets" on page 63.

One of the most intriguing features of the MB-6890 is the light-pen interface, which is standard equipment. The pen, both simple and sturdy, is extremely easy to use.

Most of the Japanese personal computers reviewed here offer a Roman-alphabet keyboard with some sort of locking shift key that allows the same keys to be used for katakana as well. There are generally a few very common kanji characters used as graphics keys (the pictographs for "date" and "time," for example), but the hiragana characters require resolution beyond the capability of most noninterlaced video displays.

Here's the way Hitachi approached the problem. The MB-6890 has an interlaced graphics mode (which doubles the vertical resolution of the characters), and in that mode, it offers you a choice of Roman, katakana, or hiragana characters. Normally, the keyboard produces Roman characters. Hit the KATA/HIRA key once and an LED beside it turns red, indicating that the keyboard is now accepting katakana input. Hit the key again and the LED turns green, indicating that the keyboard is accepting hiragana input. Hit it a third time and the LED goes out—you are back in the Roman mode.

File Operations

The Hitachi flavor of BASIC (Level-3 BASIC, a product of Microsoft) allows the programmer to pass files of data to or from any of the I/O interfaces—cassette tape, serial port, disk, printer, screen, or keyboard—using a common command format. For instance, to output a program listing to any of these devices, there is the command

LIST "*file descriptor*" [,*line number* [,*line number*]]

where *file descriptor* is a standard string that identifies the device and the other parameters are optional. Thus, LIST "LPT0:" sends the listing to printer 0, whereas LIST "CAS0:TEST" sends it out the cassette interface into a tape file named TEST.

Light Pen

One of the most intriguing features of the MB-6890 is the light-pen interface, which is standard equipment (the pen itself, however, is an option). The pen is remarkably easy to use. Since the photodiode in its tip is mounted in a retractable switch, you can both locate the pen and trigger it by simply poking the tip against the screen. The pen is simple and sturdy; numerous falls from the desk top to the floor did not seem to damage it. This interface is supported in software by Level-3 BASIC, which offers a set of keywords for controlling the light pen (see table 3).

The keywords reflect the areas where light pens are most useful:

- Option selection from a menu. The computer displays a list of choices, each one next to a box, and you in-



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ON PEN GOSUB *line number when pen in undefined area [,line number when in nth area...]*
—Branches to the *n*th subroutine when the light pen is pushed against the *n*th defined area

PEN *n*;[(*horizontal starting point,vertical starting point*) – (*horizontal end point,vertical end point*)]
—Defines rectangular areas for ON PEN command

PEN ON—Pushing pen causes an interrupt
OFF—Pen does not cause interrupt
STOP—Pushing pen does not generate interrupts, but the status is stored; the subroutine executes at the next PEN ON

PEN(*argument*)—a variable returning the following values for different values of the argument:

Argument	Value returned
0	TRUE when pen pressed
1	Horizontal position of pen when pen pressed
2	Vertical position of pen when pen pressed
3	TRUE while pen is being pressed, FALSE else
4	Current horizontal position as long as pen is pressed
5	Current vertical position as long as pen is pressed

Table 3: *Hitachi MB-6890 light-pen commands.*

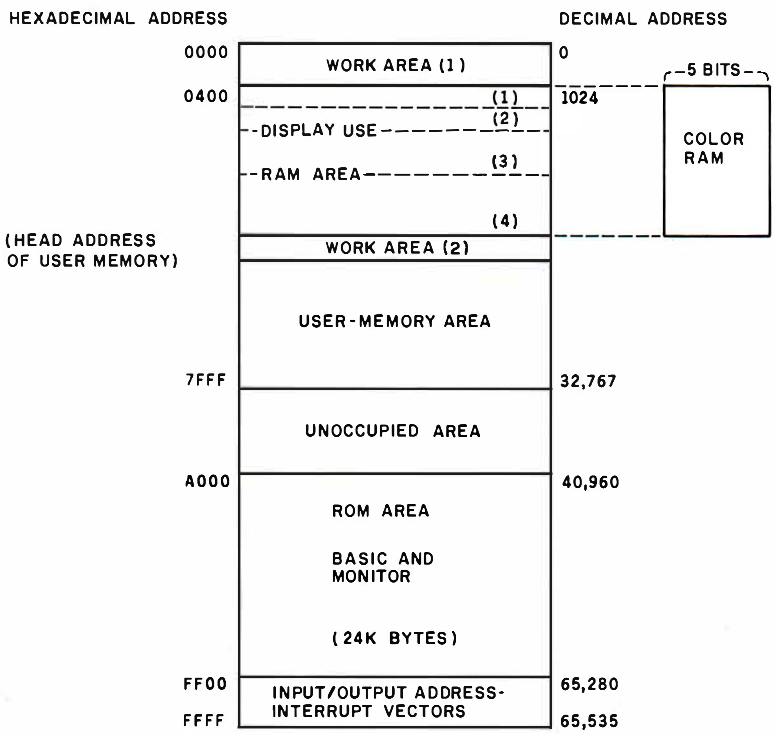


Figure 2: *Memory map of the Hitachi MB-6890. This machine has an extra 5-bit-wide segment of memory that is addressed parallel to the segment of RAM that controls the video display. The extra 5 bits are used to specify the color of the corresponding pixel.*

dicate your choice by pointing to a box with the light pen. Done properly, this can make use of the keyboard unnecessary.

- Screen location. You indicate where something is to be done on the screen by pointing to it with the light pen—much simpler than fiddling with cursors and control keys.
- Drawing. Instead of entering complicated shapes one point at a time, you just draw them on the screen using the light pen.

Nonetheless, light pens do have some inherent limitations, and the Hitachi unit is no exception. Since they work by detecting the image in the video raster on the screen and inferring the pen position from the timing of the scanning beam, most light pens occasionally make mistakes. You trigger the pen *here* and the computer thinks that it was over *there*. In the Hitachi, the light pen seems particularly prone to wraparound errors. When you touch a point near the left-hand edge of the screen, the computer thinks you touched the right-hand side. But this is a problem that a clever programmer could largely circumvent by adding a verification step, such as letting a small blinking dot confirm the entry location before the computer accepts the data.

The Hitachi system displays another problem that results from the combination of a light pen with a color video display. The photodiode in the pen is not equally sensitive to all three primary additive colors. In fact, it is blind to red. This fact is not mentioned in the English-language version of the manual, but one of the demonstration programs supplied by the manufacturer shows that Hitachi is aware of the problem. In a routine in which you are supposed to select colors by pointing to the correct sample with the light pen, each color swatch has a white square in its center.

Graphics Display

Hitachi has made an interesting trade-off between memory use and display resolution. As the memory map in figure 2 shows, some of the

	Normal		High-Resolution	
Horizontal Characters	40	80	40	80
Graphics Resolution	80 by 100	160 by 100	320 by 200	640 by 200
Color Resolution	40 by 25	80 by 25	40 by 200	80 by 200
Memory Required/Screen	1K	2K	8K	16K
Character Mode Usable	40 by 25	80 by 25	40 by 25	80 by 25
Character Matrix	8 by 8 pixels		8 by 16 pixels	
Maximum Pages	16	8	2	1
Memory Available to BASIC	29,546	28,522	22,378	14,186

Table 4: *Hitachi display modes.*

RAM is taken up by the display; how much depends on resolution. Apparently, a separate 5-bit-wide memory that controls color parallels the main memory. In the highest resolution mode, each pixel (picture element) of the 640- by 200-pixel screen can be turned on or off individually, but only one color in addition to the background color is available to pixels in a given color-resolution cell. Thus, lines of different colors intersecting within one color-resolution cell take the color of the last line entered. This means that extremely high-resolution graphics are possible if you either restrict yourself to one color in addition to the background color or are very careful about where and how different colored lines intersect. If you are not careful, you get lines changing colors and "jaggies" along diagonal borders between areas of different colors.

As table 4 shows, you are also able to trade off resolution against the number of video pages, where each page may contain a different picture. Although it may take a relatively long time to draw a particular picture, it is possible to put separate pictures on separate pages and rapidly flip back and forth by switching pages. This feature could be useful for animation, games, storytelling, or graph and chart presentation.

Peripheral Devices

In addition to the display and light pen mentioned above, the system we evaluated included the Hitachi MP-3540 dual floppy-disk drive and MP-1040 dot-matrix printer. The connectors were well marked and designed so that they could not be inserted backward. Thus, it is nearly impossible to assemble the system incorrectly. We put everything together in less than five minutes without even looking at the manual. Hitachi, unlike some of the other manufacturers discussed here, included generous lengths of cable (more than three feet for each unit). The sockets for D-shaped connectors had wire ears that locked them in place so that they could not accidentally be pulled loose.

The dual 5¼-inch floppy-disk-drive unit is reasonably compact, measuring 27 by 27 by 21 cm (10⅝ by 10⅝ by 8⅛ inches), and unbelievably sturdy. The two drives are mounted vertically in a thick (1.65-mm, 0.065-inch) aluminum chassis that looks like it could withstand any abuse short of artillery fire. It weighs 11 kg (24 pounds).

Surprisingly, the disk drives are fan-cooled, even though the keyboard/processor unit is not. And, in addition to the power switch on the back, a "Motor" button on the front starts the drives spinning, independent of whether the processor is trying to read or write a disk. This might be useful if you have trouble centering disks when you put them in. A disk mounted on a rotating spindle tends to center itself.

The doors to the drive units do take a bit of getting used to. Instead of flipping a latch, to open a door you *push* the door in, and a spring pops it open. The springs are very firm, and you initially get the erroneous feeling that you are crunching the floppy disk.

The disks are soft-sectored and single-density, with 128 bytes per sector. With 16 sectors per track and 40 tracks per disk, each disk can store a total of about 80k bytes. The middle tracks on each disk are reserved for the directory.

The Disk BASIC supplied with the system supports both sequential and random-access files. Also, it has a command that permits you to write to a specific sector on a specific drive, irrespective of file status. (This could be a dangerous command; using it carelessly could wipe out files, or even the directory.)

The MP-1040 printer is remarkably quiet and quick, the latter due to the bidirectional motion of the print head that causes the characters to appear on the paper boustrophedonically. The MP-1040 is a bit wider than the disk unit, measuring 36.1 by 32.8 by 13.3 cm (14¼ by 13 by 5¼ inches), but its rubber feet are close enough together that it can sit on top of the disk drives if necessary. It can handle either fan-folded or rolled paper, either friction- or sprocket-feed, and can print not only Roman and katakana characters, but the more detailed hiragana characters as well. A rotary switch on the front panel allows the selection of 10 different form lengths, and push-button switches manually cause form and line feeds.

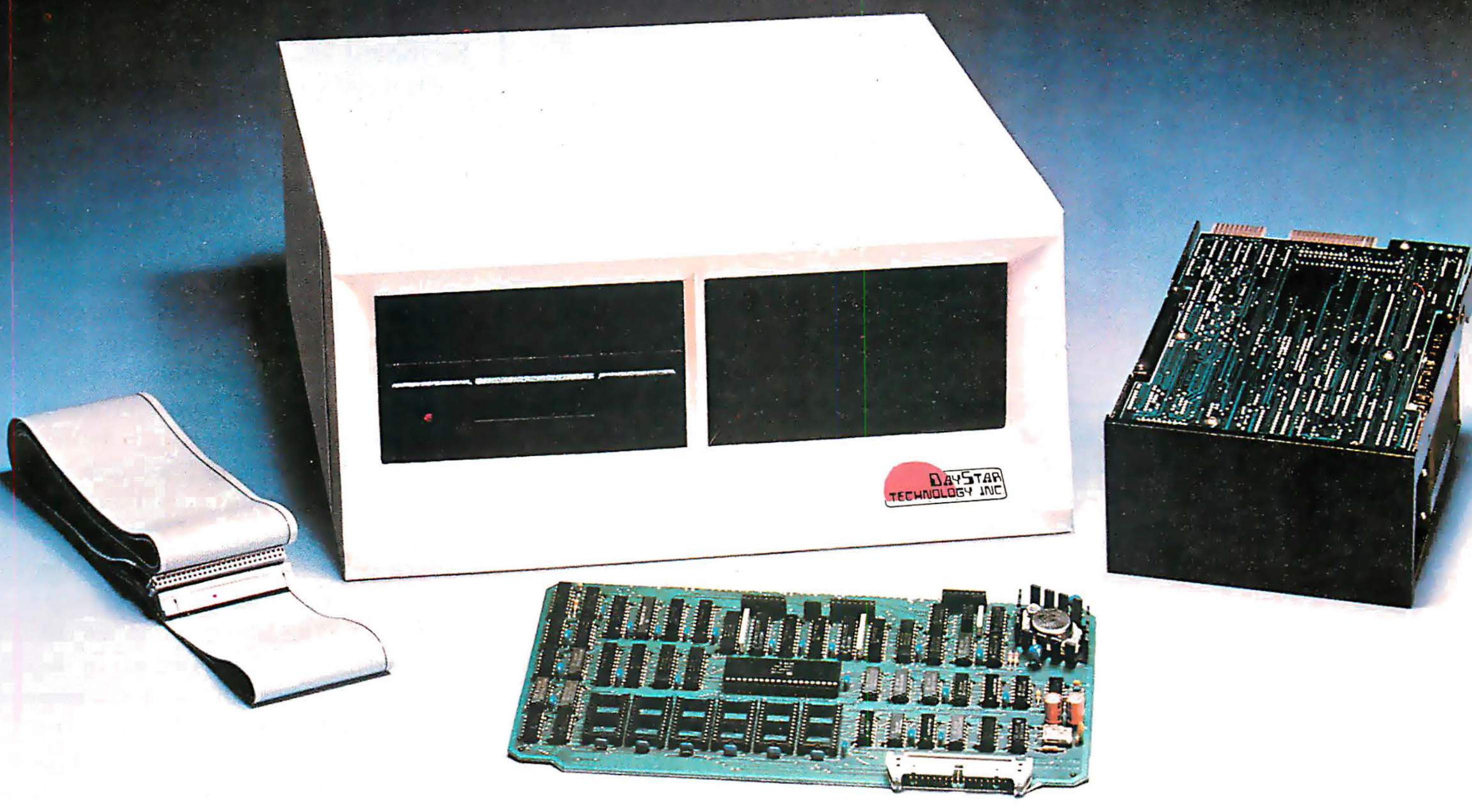
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Fujitsu FM-8



Photo 13: *The Fujitsu FM-8 computer. Shown here are the keyboard/processor module, color monitor, and two disk drives, all connected together with lengthy cables for ease of rearrangement. Other optional hardware includes a printer, modem, joystick, and Z80-processor card.*

Update

At press time, we learned from Fujitsu that the company does not plan to sell in America the version of the FM-8 reviewed here. Instead, there is a strong possibility that Fujitsu will introduce an American version of the unit some time in the near future.

With the Fujitsu FM-8 ("Fujitsu-Micro 8"), we were faced once again with the unenviable task of attempting to use a computer for which documentation is not yet available in an English version. (We first went through this when we obtained our original Japanese-version NEC PC-8001.) Fortunately, many technical terms in the manual are written in katakana or English. Therefore, we were able to decipher most of the salient features of the machine and obtain a fairly good working knowledge of it.

Hardware at First Look

The FM-8 computer system consists of three modules: keyboard/processor, 5¼-inch floppy-disk drives, and video monitor, as shown in photo 13. Unlike some of the other computers, however, they are connected with long cables that can be rearranged to fit available desk or wall space. A four-foot ribbon cable goes from the keyboard through a small interface box to the disk drives, and an even longer round cable with DIN connectors goes to the color video monitor.

Keyboard and Controls

The keyboard has 95 keys in all, including most of the familiar ones encountered already (10 function keys, numeric keypad, editing keys). It does have a few unique features, however. Three of the keys, the CAP (uppercase lock) key, the katakana key, and the INS key, have adjacent red LEDs to indicate their status.

The INS key toggles the computer in and out of insert mode. When in insert mode, characters can be inserted in the middle of lines, and the line is automatically shifted over to accommodate the new characters.

Two other interesting keys are the EL (erase line) key and the DUP (duplicate) key. The EL key performs the standard erase-to-end-of-line function, which is useful but not often found on a keyboard. The DUP key causes the contents of the previous line to be duplicated into the current line being typed, up to the next tab stop. In other words, hitting the DUP key will enter as many as eight characters from the previous line into the current line. This is useful, for exam-



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At a Glance

Name
Fujitsu FM-8

American Representative
Fujitsu America Inc.
2945 Oakmead Village Court
Santa Clara, CA 95051
(408) 727-4300

Dimensions (inches)
4¼ by 19 by 13¼

Microprocessors
Two 8-bit 6809s, one 4-bit 8841

Size of User Memory
64K bytes

Number of Keys
95

Number of Function Keys
10

Standard Interfaces
Analog input; RS-232C; expansion port; monochrome video monitor; RGB color monitor; printer

Optional Interfaces
Z80 processor card; disk drives

Expansion Sockets
1 (for Z80 card); 1 for system bus

Character Sets
Roman, katakana, graphics; optional: hiragana, Greek, Cyrillic, kanji

Graphics/Color Resolution
640 by 200

Number of Colors
8

Other Features
Time-of-day clock; optional bubble memory

Prices (Yen Equivalent in Dollars)
Y = $3400 (entire system)
Keyboard/processor Y = $1035
Color monitor Y = $ 860
Disk drive Y = $1500
Z80 expansion card Y = $50

ple, if you have two lines in a program such as:

```
100 A=C(I,J)+D(I,J)+4*E(I,J)
110 R= C(I,J)+D(I,J)+4*E(I,J)
```

Once you have typed line 100, you merely type "110 R=" and then hit the DUP key a few times to enter the rest of the line, which will be copied from the previous line.

The on/off switch for the computer is located under a hinged door in the upper right-hand corner of the keyboard. In our unit, there is nothing else under this door except a little niche that's just the right size for storing a bag of peanuts or a candy bar (to provide a little extra sustenance on those long nights of computing).

Fujitsu's engineers actually reserved this space to contain two optional bubble-memory-cartridge sockets. (We discuss bubble memory more in the review of the Bubcom80, coming up next.)

The back of the keyboard/processor unit contains jacks for several standard interfaces: floppy-disk drives, serial RS-232C ports and parallel printer port, color video monitor, monochrome video monitor, and audio-cassette tape. A DIN jack labeled ANALOG IN provides at least two analog input ports that can be read from BASIC or assembly-language software. These ports can be used, for example, for connecting game paddles or a joystick. There is also a 10-position DIP switch for setting various default parameters such as data rate and parity format for the remote-terminal mode.

The Fujitsu FM-8's multiprocessor division of labor shows up in speed.

Inspecting the Interior

Inside the keyboard/processor module, several surprises await you. First, it has three microprocessors! Two are 8-bit 6809s, one serving as the central processor with the other dedicated entirely to handling video-display functions. The third one, a 4-bit microprocessor (a Fujitsu 8841), handles keyboard scanning. This division of labor means that the main processor is somewhat less taxed than in single-processor designs. This shows up in speed. The FM-8 was the fastest of the six computers reviewed here in a BASIC benchmark test that will be described later.

The main bank of random-access read/write memory is composed of eight 64K-bit memory chips, yielding 64K bytes. An additional 48K bytes of memory store the high-resolution video bit map composed of twenty-four 16K-bit chips.

Also taking up a significant area on the printed-circuit board (in the lower left-hand corner) are 16 integrated-circuit sockets, visible in all their bright-blue glory in photo 14. These were empty in our unit, but are intended to hold up to 16 ROM (read-only memory) chips. These ROMs provide the FM-8 with an amazing capability—an extra character set of 8500 characters! Approximately 8000 of these are Chinese-derived kanji characters; the remaining 500 include complete alphabets (uppercase and lowercase) of Cyrillic (used for Slavic languages, including Russian), Greek, Roman, and hiragana characters, plus some special symbols. Due to the intricate detail of the kanji pictographs, the auxiliary characters are formed in a 16 by 16 dot matrix, and are thus roughly twice the size of the ordinary characters. This character set is accessed from BASIC with the PRINT (x,y),A statement, where A is the hexadecimal address in ROM of the character desired; a table in the user's manual gives addresses for all the characters. Presumably, you could make your own ROMs containing characters for Arabic, Hebrew, APL, or whatever you like!

And if three microprocessors aren't enough, an optional Z80 processor card is available. It appears that this card is required to drive the alternate-

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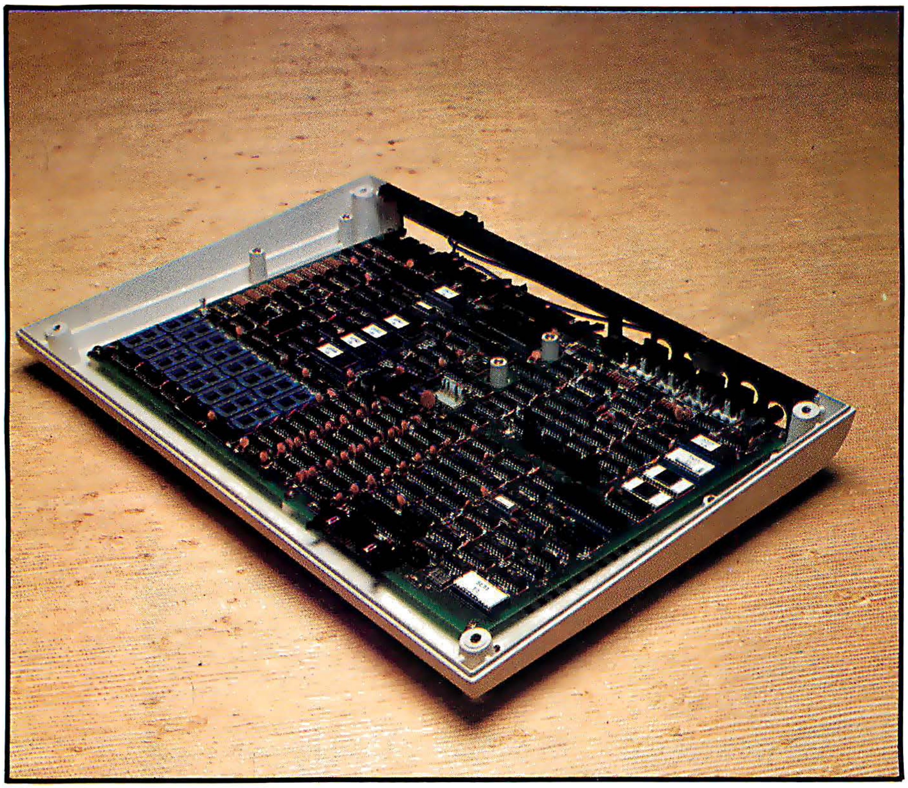


Photo 14: *Inside the keyboard of the FM-8. Visible in the lower left are 16 ROM sockets for the alternate-character-set ROMS.*

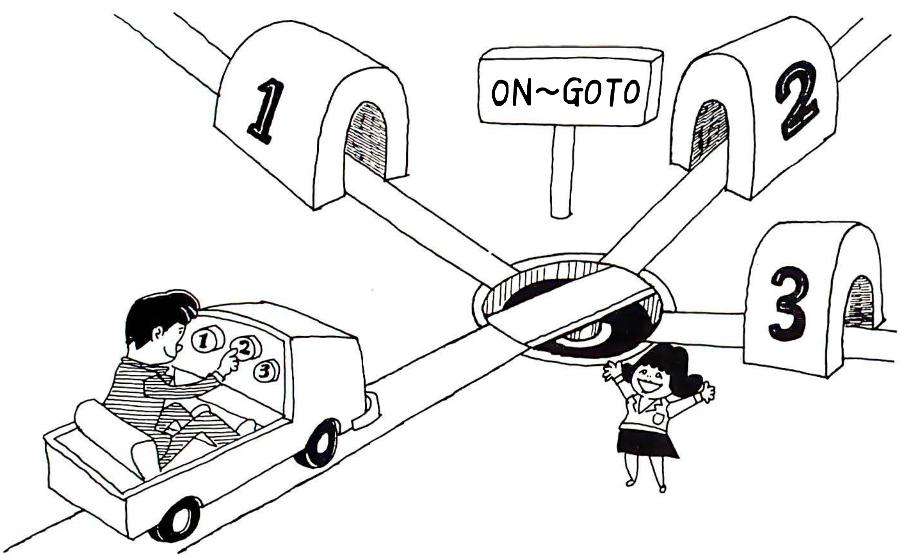


Figure 3: *An excerpt from the Fujitsu FM-8 Japanese-language tutorial BASIC manual, illustrating the ON...GOTO statement. The manual contains many such elegant and humorous drawings that are used to teach programming in BASIC.*

character ROMs, but it apparently can be used as a general-purpose processor as well, since CP/M and other Z80 software are available for the FM-8.

BASIC Interpreter

Before we describe the software's capabilities, we want to praise whoever wrote the tutorial BASIC manual. Even though we could not read all of it (our edition is in Japanese), we were impressed by the simplicity and humor with which it teaches programming. (It is reminiscent of Roger Kaufman's *A FORTRAN Coloring Book*.) It is sprinkled liberally with good programming examples and amusing illustrations, like the one shown in figure 3, depicting the operation of various BASIC keywords. The other two manuals that come with the FM-8 (system-reference manual and BASIC-reference manual) also appear to be quite good (as far as we can tell).

The FM-8 dialect of BASIC (called FBASIC) is in many ways similar to some of the other BASICs reviewed here, supporting most of the same text, graphics, and I/O keywords as the others. It does have a few extra capabilities, however.

Of the graphics statements available, most notable is the CONNECT (*x1*,*y1*),(*x2*,*y2*),...,(*xn*,*yn*) statement. This statement draws a connected line segment through the points indicated, and can be used, for example, to draw polygonal outlines. Since most of the computers reviewed here have a polygon-fill command (PAINT), it is surprising that the FM-8 is the only one with a single command to draw an empty polygon (on all the others, you must use LINE commands in a loop to draw the line segments of the polygon). With the CONNECT command, it takes only two program statements to draw a filled polygon—you CONNECT it, then PAINT it.

Another unique keyword is SYMBOL, which provides the FM-8 with the unique ability to write multiple-

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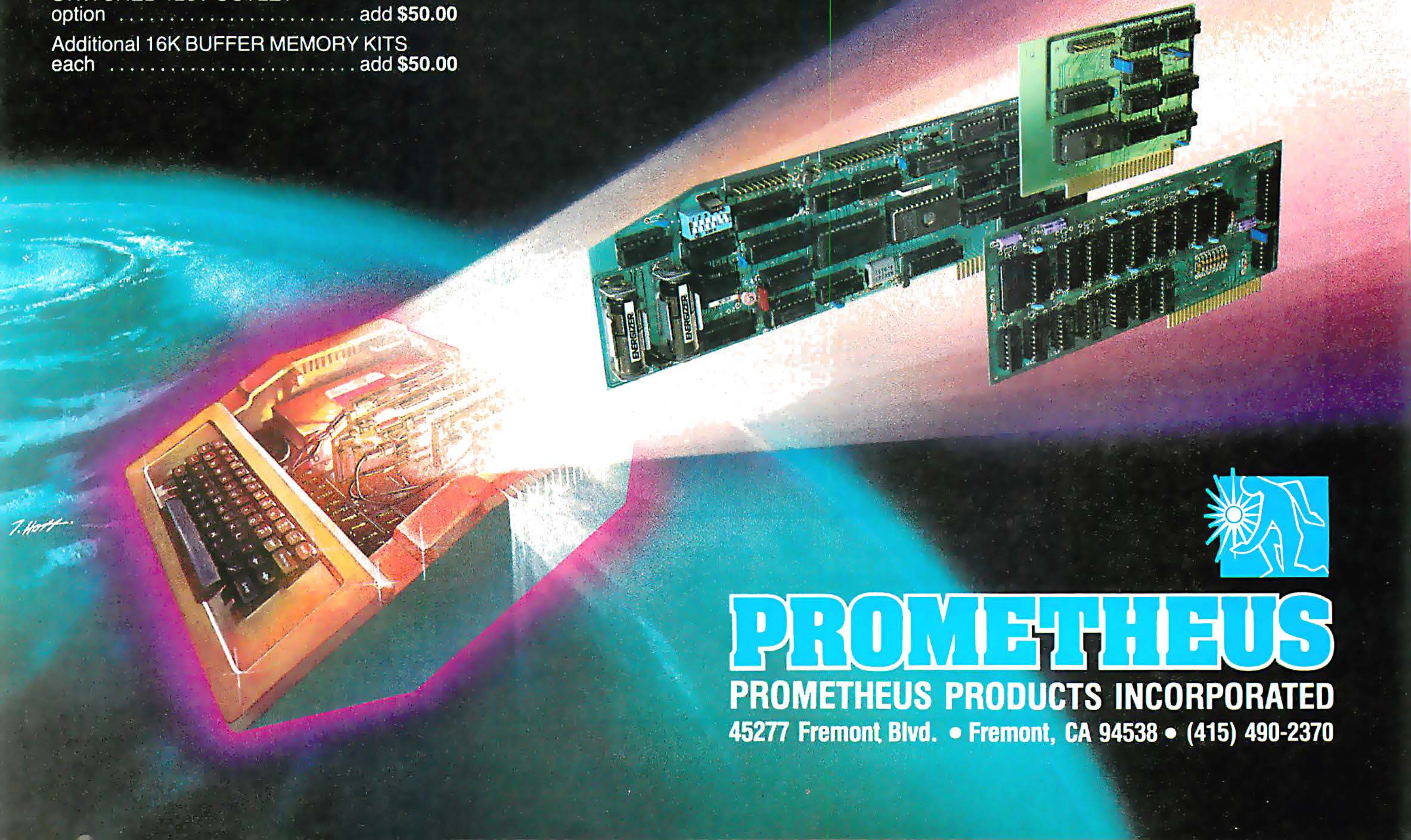
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size text. The syntax of the statement with all possible parameters is:

SYMBOL (*x*,*y*),*string*,*x-scale*,
y-scale,*color*,*rotation*

The *x*- and *y*-scale factors cause the characters printed to be scaled in size (independently in each axis, if desired) and rotated (by multiples of 90 degrees). This is very handy for labeling graphs, for example.

To assist in programming, FBASIC has a MERGE command, which allows the combining of two or more programs from disk into one large program. Another command bears the somewhat whimsical name of UNLIST. We still aren't sure exactly what this does. Issuing the command UNLIST 50, for example, causes the program currently in memory to become unlistable starting at line 50. (It still runs normally, though.) Thus, it seems that the command might be similar to the SECURE command on the Canon CX-1. Unfortunately, there doesn't seem to be a way to undo an UNLIST.

Also quite useful is the ANPORT function, which reads an analog input port, does an 8-bit A/D conversion, and returns a value in a BASIC variable.

Bubcom80



Photo 15: *The Bubcom80's high-resolution monitor has a contour at the bottom that lets it fit snugly against the keyboard/processor enclosure. Slots in the top of the keyboard enclosure accept bubble-memory cartridges.*

Bubble memories—are they the wave of the future or a vestigial remnant of a technological dead end? In the past year, three American manufacturers have pulled out of the bubble-memory business. On the other hand, several Japanese manufacturers are putting bubble memories into personal computers, either as standard equipment or as an option, in what may be either an attempt to stimulate a lackluster market or an anticipation of wonders to come.

A computer that offers bubble memory as a standard feature is the Bubcom80 (see photo 15), a Z80-based machine developed jointly by Fujitsu, one of the Japanese manufacturers of bubble memories, and Systems Formulate Corporation, a company founded by former Fujitsu employees with that company's encouragement and blessing.

But bubble memory is not the only attraction of the Bubcom80. Let's take a look at some of its other virtues first.

Hardware

The main keyboard/processor module offers a remarkable collection of features for the price. It has all the features that are standard on the Japanese computers: separate numeric and editing keypads; user-programmable function keys; RS-232C serial interface; and Roman, katakana, and graphic input. It also

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At a Glance

Name
Bubcom80

Distributor
Systems Formulate Corporation, U.S.A.
231-E South Whisman Rd.
Mountain View, CA 94041
(415) 969-7499

Dimensions (inches)
3⅝ by 17⅞ by 12¼

Microprocessor
Z80, 8-bit

Size of User Memory
64K bytes

Number of Keys
99

Number of Function Keys
8 definable, 8 defined

Standard Interfaces
RS-232C; audio-cassette tape; monochrome video monitor; RGB color monitor; printer; expansion bus; joysticks; two bubble-memory controllers

Optional Interfaces
Floppy-disk drives; high-resolution graphics

Expansion Sockets
1 (systems bus)

Character Sets
Roman, katakana, user-definable graphics

Graphics/Color Resolution
160 by 100 (standard); 640 by 200 (optional)

Number of Colors
8

Other Features
Time-of-day clock with battery backup; speaker with music macroinstructions

Prices
Keyboard/processor $1550
RGB color monitor $1400 (with expansion box)
Disk drive $1275 (+$450 for interface board)

offers a set of eight keys for single-key entry of system commands (LABEL, FILES, INIT, STOP, CLS, EDIT, LIST, and RUN).

Connectors are included for both a light pen and joysticks. The numeric keypad, in addition to the 10 digits, includes a 000 key to facilitate the entry of large numbers. A loudspeaker can produce tones (with pitch manipulated by instructions written in a sort of sublanguage similar to the BMC's MML) to provide rudimentary music. And, of course, it has sockets for bubble-memory cartridges. One socket comes as standard equipment; the second is a $175 option.

The keyboard enclosure is a little larger than the keyboard itself, measuring 44.5 by 10 by 30.5 cm (17½ by 3⅞ by 12 inches). Except for a sheet-metal bracket on the rear, which houses the power supply, the enclosure is all plastic. Apparently, its interior has been sprayed with conductive paint to provide electromagnetic shielding. If you push in two plastic tabs under the front edge of the enclosure, you can tilt up the keyboard for access to the circuit board inside.

Space inside the case is understandably tight. The main printed-circuit board holds the Z80 microprocessor and associated circuitry, 64K bytes of main memory, the read/write memory for the user-definable graphic-character set, a counter-timer integrated circuit, various interface chips, and some rather large custom integrated circuits, whose function we are unsure of. A small area (about 2.5 by 7.5 cm, 1 by 3 inches) of largely unused plated-through holes in the board is something that an ambitious user might be able to use for patches or custom circuitry.

Bubble memory is not the only attraction of the Bubcom80.

Three other circuit boards are suspended from the keyboard backplane. Two of these are attached to sockets for the bubble-memory cartridges; the third contains circuitry that we assume scans the keyboard and/or operates the bubble memory. One of the mystery circuits on the board is an 88-pin monster with two rows of pins along each side of a square package.

Software

The Bubcom80 can use nearly all 64K bytes of its memory-address space for read/write memory because, aside from its bootstrap loader, no ROMs for a BASIC interpreter or an operating system are taking up address space—you must boot the system by loading the operating system and interpreter into user memory either from bubble memory or from cassette tape or disk storage. This, of course, gives more software flexibility than the ROM BASICs—a sophisticated user who wants to run assembly-language programs or some language other than BASIC need not sacrifice address space to a BASIC interpreter.

The system we tested came with two versions of BASIC. The standard BASIC, which apparently does not support some of the high-resolution graphics features, left 29,710 bytes of memory free; the extended BASIC, which does support the high-resolution graphics, left 23,610 bytes of memory free. The system specifications indicate that the CP/M operating system will also be available for the Bubcom80, although we did not have a copy.

The extended BASIC (yet another Microsoft product) has several particularly useful keywords (see table 5).

The most notable one is MENU—a real boon to anyone who wants to write programs with menus for selecting options. It allows a program writer, with a single statement, to display a menu of labels anywhere on the screen. When the statement is executed, the labels are displayed on the screen and the cursor blinks on the bullet in front of the first menu item.

```
MENU(hor,vert)spacing "label1","label2"...GOTO    Address1,Address2...

MENU(hor,vert)spacing "label1","label2"...GOSUB    Address1,Address2...
```

—Displays a menu of labels, starting at (*hor,vert*), with number of lines between labels set by spacing parameter. Cursor flashes in front of first label; pushing space bar advances cursor to next line; typing RETURN causes a branch to appropriate address or subroutine.

```
OPTION BASE 0
OPTION BASE 1
```

—Specifies the starting value of array indices.

Table 5: *Useful Bubcom BASIC statements.*

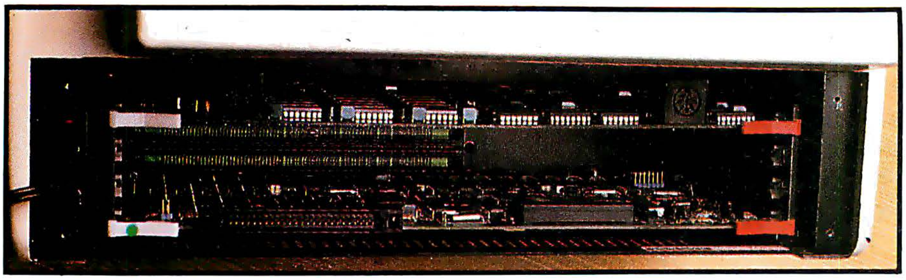


Photo 16: *The Bubcom color-console/expansion box has slots for four 30.5-cm (12-inch) circuit boards.*

If you hit the oversized RETURN key, the program branches to the subroutine or address associated with the first label; if you hit the space bar, the cursor drops down to the next label on the menu. Hitting the space bar when the cursor is in front of the last item on the menu sends it back to the first item on the list.

The BC834 console color video display with expansion box, shown in photo 16, is a bit expensive, but it offers more than most displays. The 40.6- by 40- by 37.5-cm (16- by 15¾- by 14¾-inch) high-resolution color CRT (cathode-ray tube) sits directly above the expansion box, which connects to the system bus and contains slots for four 30.5-cm (12-inch) circuit boards.

The back of the console has something more computer manufacturers should provide: a switched set of four AC power outlets. Thus, you need not hunt around for extension cords and spare outlets to handle your computer and all its peripheral devices. You plug one cord into the wall and plug everything else into the switched outlets. You can then turn all components on or off together with a single switch.

The bottom front of the BC834 is recessed so that the keyboard/processor module can nestle snugly under the screen. In fact, it *must* fit snugly; the flat cable that connects the expansion unit to the back of the keyboard is no more than 7.5 cm (3 inches) long. This makes the system very difficult to plug together; you need skinny fingers and lots of patience to place the edge connector correctly and push it home.

Both the high-resolution graphics board and the floppy-disk-controller board go into the expansion box. While the connections to the floppy-disk board are straightforward, the connections to the graphics board are a little bit complicated—the graphics board plugs into the system bus in front and has two unmarked DIN connectors that poke out through holes in the back of the box. To install the board, you must run one cable from the back of the keyboard to the input DIN connector on one side of the graphics board and run another cable from the output DIN connector to the display input. A few labels on the connectors would be very helpful; as it is, you cannot connect the system correctly without consulting the diagram in the user's manual.

Without the high-resolution board, the processor's output can be connected directly to the display input. This mode of operation provides a graphics resolution of 160 by 100 pixels.

With the extra display memory on the high-resolution board, the resolution is 640 by 200 pixels, and the color of each pixel can be specified individually. The high-resolution display is organized as three separate conceptual planes, one each for red, blue, and green. When you clear the high-resolution screen, the three planes are erased sequentially, rather than simultaneously. The effect can be startling.

The main processor memory provides for a fourth character plane, which allows text to be displayed on top of the graphics plane; the text can be written, scrolled, or erased without disturbing the picture drawn on the graphics plane and underneath. Thus, you can list a graphics program on top of the display it creates to compare cause with effect.

Graphics keywords include PAINT, LINE, and CIRCLE, and a graphics macro language similar to that of the BMC is provided. Some of the graphics operations proceed slowly, particularly the PAINT routine. But the display is bright and luminous—figures drawn against a black background appear to float in space.

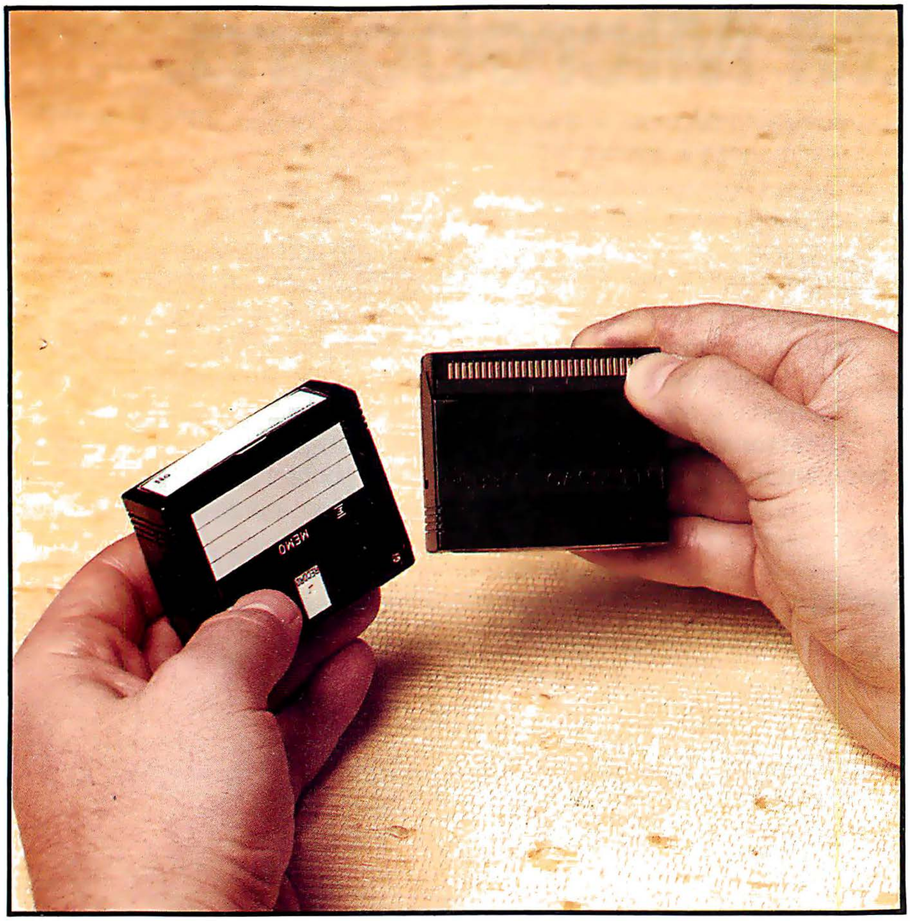


Photo 17: *Each Bubcom bubble-memory cartridge holds 32K bytes. The white slide is a write-protect key.*

Floppy-Disk Storage

The Bubcom80's floppy-disk drive, unlike the others reviewed here, uses double-sided IBM-format soft-sectored 8-inch floppy disks. Each disk can hold a whopping 1.2 megabytes, and if one drive is not enough, up to three more can be daisy-chained to the first one. But in spite of its capability, the vertically mounted drive unit takes remarkably little space—it is only 18.4 cm wide, 36.8 cm high, and 40.6 cm deep (7¼ by 14½ by 16 inches).

Curiously, a battery-backed-up real-time clock is on the disk-controller board. (When we started the system, the Bubcom80, like the BMC, displayed the correct time, but it was set for the Tokyo time zone.)

Bubble Memory

What about the bubble memories? How do they work and what do they do?

The bubble-memory cartridges, shown in photo 17, are black plastic rectangular packages about the size of a small match box—6.0 by 4.5 by 2.0 cm (1.8 by 2.4 by 0.8 inches). On each one is a little white plastic slide switch that can be used to write-protect the data on the front of each cartridge; a black plastic window at the bottom front of the cartridge covers the metallic contacts on the bottom and slides out of the way when the cartridge is shoved into one of the sockets. You release the cartridge from its socket by pushing a lever on the side of the socket.

Inside each cartridge, circuitry creates magnetic domains—bubbles—and moves the patterns of bubbles along circular loops. The data cannot be accessed in a completely random fashion, in the way that data in main user memory is. To reach bits at the far end of a loop, you must cycle the intervening data past the read element, just as you must pass over sectors 1 through 15 before you read sector 16 on a disk. But because there is virtually no inertia to overcome when moving the bubbles, the average access time needed to read or write a given set of data is much less for a bubble cartridge than for a disk. (For more information, see A. I. Halsema's article "Bubble Memories: A Short Tutorial," June 1979 BYTE, page 166.)

Since the bubbles remain intact in the medium when power is removed, bubble cartridges can be removed and stored just the way disks can. The bubble cartridges supplied with the Bubcom80 machine we evaluated each hold 32K bytes of data, but Fujitsu, the manufacturer of the cartridges, promises that 128K-byte cartridges will be available in a year.

From the user's viewpoint, the bubble cartridges act just like disks. The software pretends that the two bubble-memory controllers are disk drives 1 and 2; the disk drives are considered drives 3 through 6. All the BASIC commands for disks, LOAD, SAVE, OPEN, CLOSE, etc., work the same for the bubble memories.

Two LEDs, labeled BUSY and READ ONLY, tell you when the bubble memory is in operation and when you are trying to write to a cartridge that is write-protected. The most noticeable difference is the speed of operation. Because there are no motors to start and bring up to speed, and no heads to move, the bubble memories are much faster.

Why Use Bubble Memory?

One disadvantage of the bubble cartridges is the price, currently $175 for a 32K-byte bubble cartridge; standard BASIC in a bubble cartridge costs $200, as opposed to $25 on cassette tape and $50 on an 8-inch floppy disk. Whether the prices come down substantially will undoubtedly depend on how widely used bubble memories become. On the other

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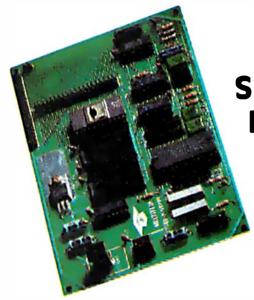
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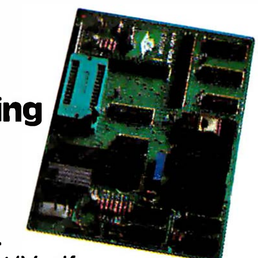


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hand, the bubble-memory controllers are much cheaper than disk drives.

The greatest advantage of bubbles over disks is the shorter data-access time. Then, too, in certain environments—abrasive, dusty atmospheres, for example—bubble memories could be expected to be much more reliable than disks. Thus, certain applications exist even today where the bubbles might be preferred to disks. Whether bubble memories will replace disks in more widespread applications depends on how quickly and how far their prices drop. Nevertheless, the Bubcom80 remains an interesting adventure into this new technology.

Comparisons

Test	if800 (MBASIC)	if800 (Oki BASIC)	Canon	NEC	Bubcom	Fujitsu	Hitachi
1. FOR...NEXT	9.7	9.7	15.5	9.4	12.5	8.9	12.8
2. 10 REMs	46.3	22.1	21.5	27.8	30.2	24.0	26.9
3. IF A>B	22.3	23.4	32.8	28.9	30.3	24.2	35.8
4. A+B	23.5	25.1	28.2	25.9	32.4	27.7	40.6
5. A*B	28.9	32.8	47.2	32.3	42.5	30.3	49.8
6. A/B	34.4	40.6	1:15.1	40.8	52.5	38.4	52.0
7. A↑B	2:49.3	3:52.2	15:57.6	3:17.5	4:57.1	2:14.8	4:15.7
8. SIN(A)	1:26.0	1:50.0	5:55.2	1:43.0	2:23.5	1:15.3	2:11.1
9. LOG(A)	1:32.3	1:56.7	10:25.0	1:30.4	2:35.6	1:08.4	1:56.9
10. ON...GOTO	22.2	23.4	24.6	20.8	30.2	21.1	30.1
11. GOSUB	18.6	15.9	17.5	15.0	19.9	14.8	21.8
12. INT	23.3	25.0	24.8	25.3	32.4	25.8	35.9
13. MID$	25.3	29.8	31.0	30.2	38.3	28.4	41.4
14. RND	29.6	33.5	2:04.0	31.7	43.5	26.4	43.8
15. CHR$(X)	21.0	21.6	24.4	21.7	27.9	19.8	32.0
16. Sieve	2:44.5	2:56.7	2:35.3	2:44.5	3:48.9	3:10.0	4:51.8

Table 6: *Results of the benchmark comparison of the six Japanese computer systems. The tests were run twice on the BMC if800, once with each BASIC interpreter. The simple operations in the left column were repeated 5000 times; the prime-number-finding sieve was the most complicated algorithm in the test.*

This completes our individual summaries of the features of the six Japanese computers.

But what about performance comparisons, especially speed of program execution? How fast do they execute the same BASIC program? Since execution speed depends on many different things, such as the type of microprocessor, clock rate, and efficiency of the language implementation, it is not easy to predict how a system will perform in this respect.

To compare these six computers, we ran a comprehensive set of 16 benchmark programs. The results of these comparisons are shown in table 6. Each benchmark tests one feature of BASIC, typically using a program to do 5000 iterations of a simple operation (such as C=A*B). The only exception to this pattern is benchmark 16, which is a program to find all prime numbers less than 10,000 using a simple sieve algorithm.

Without attempting to draw too many conclusions from these data, we can safely say that the Fujitsu FM-8 is the fastest of the computers, followed closely by the BMC if800. This is not surprising because of the FM-8's multiprocessor architecture. The Canon CX-1 is usually the slowest of the six, except in a few cases where the Hitachi is slower.

Additional data for comparison can be found in the "At a Glance" boxes accompanying this article. Data on the floppy-disk drives appears in table 7 on page 102.

Conclusions

The Japanese penchant for high quality and flexibility is readily apparent in these computers. The keyboards are durable and have many keys (usually including programmable ones). The video displays are either green-phosphor monochrome or color RGB- (red, green, blue) input monitors for crisp 80-column displays. The standard BASIC interpreters have many language extensions for supporting peripheral devices and usually contain a few abilities not found in most computers.

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	BMC	Canon	Hitachi	NEC	Fujitsu	Bubcom
Drive size (inches)	5¼	5¼	5¼	5¼	5¼	8
Number of drives	2	2	2	2	2	1
Sides/disk	2	2	1	1	2	2
Tracks/side	?	?	39	34	39	76
Sectors/track	?	?	16	16	16	26
Bytes/sector	?	?	128	256	?	?
Total bytes per disk	280k	320k	81k	139k	328k	1.2M
Price per drive	not applicable		$1354	$1295	$1500	$1275
Price/interface card						$450

Table 7: *Comparison chart of the six units' floppy-disk systems. Some specifications were not known at the time of this writing.*

Prices for these computers may seem a bit high, and they would seem higher still if we factored in import and export costs and a less favorable yen/dollar exchange rate. But you must remember that these prices include many capabilities (both hardware and software) that are not standard on most American computers. All these machines, for example, have user-definable function keys and full numeric keypads, in addition to the standard typewriter keyboard. Most of them have simple commands that allow them to serve double duty as a remote terminal for another computer. This should be considered when comparing these machines to other currently available personal computers.

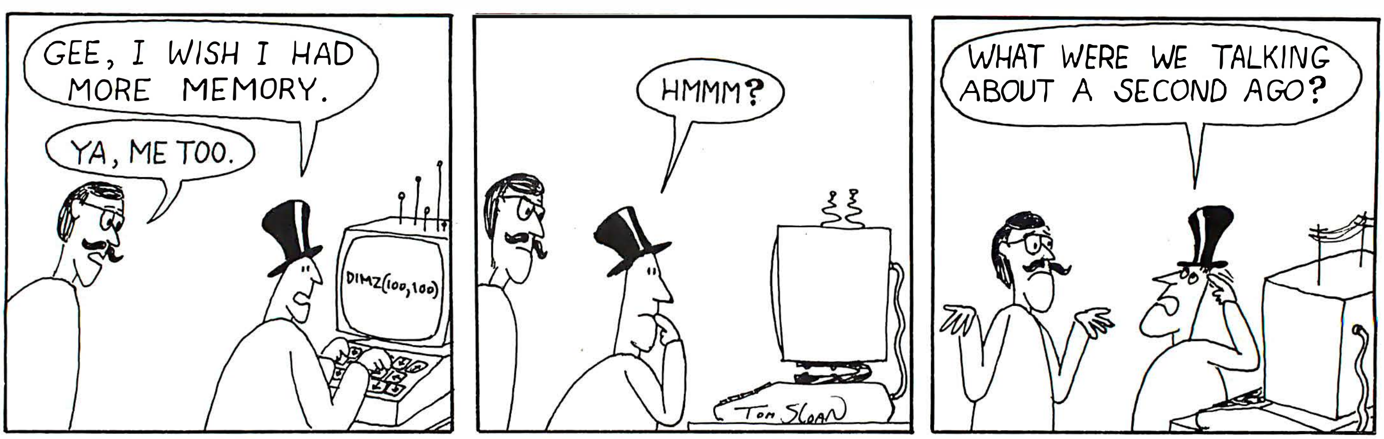
The six computers have a 50/50 split between use of the 6809 and Z80 microprocessors. The Fujitsu FM-8 uses three microprocessors (two 6809s plus a 4-bit 8841). Thus, it has an inherent speed advantage over most of the others. Otherwise, neither the 6809 nor the Z80 machines have a clear-cut speed advantage.

While individual system modules are all well designed, at least some of the manufacturers have paid inadequate attention to how the components fit together. Cables are too short, connectors are difficult to insert and remove, and the systems will not readily fit onto a crowded desk top or laboratory bench. Not everyone wants the display directly behind and above the keyboard.

Because most of the BASIC interpreters (all except Canon's) were written by Microsoft, the versions of BASIC are very similar. It is nevertheless noteworthy that many keywords and features not found in most American machines are common to all Japanese computers. (An exception is the new IBM Personal Computer, which has a Microsoft BASIC system that resembles the ones in the Japanese machines.)

Although we have not really addressed the problem here, it is apparent that one major problem the Japanese manufacturers will have to address in penetrating the American market is documentation. Most Americans have experienced the atrociously translated instructions that come with many cheap Japanese toys and consumer goods, and they are likely to be very critical of instructions that are badly translated or confusing. Money allocated by the manufacturers for producing polished translations of software and hardware manuals would be well spent.

Will Japanese personal-computer manufacturers gain a significant portion of the market in North America? It's anybody's guess. Their prices may be slightly high, but they offer quality, along with a mix of features not found in domestically produced machines. And, as the automakers found, entrenched American competition may not be a significant impediment. ■



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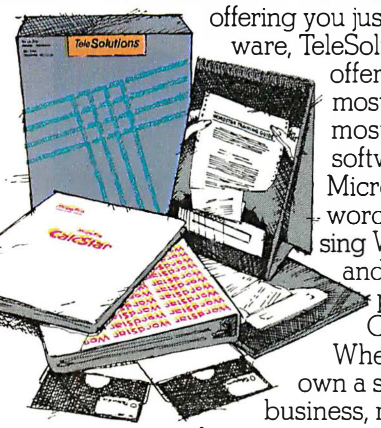
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Japan Update

The semiannual Consumer Electronics Show is on its way to becoming a showcase for new computer products.

Mark Haas
Managing Editor

The Japanese, formidable competitors in many U.S. and foreign markets, are making great headway into our domestic microcomputer industry. While a large percentage of components of American-made microcomputers are made in Japan, few microcomputers up until now were actually manufactured by Japanese companies in Japan. This situation is rapidly changing, however. At the Consumer Electronics Show, held in Las Vegas in January, I previewed several new Japanese entries into the United States market by Casio, NEC, and Toshiba. Some companies were featuring soon-to-be-available machines; others were just offering a taste of what they'll be showing at next month's National Computer Conference in Houston. (For an extensive report on what the Japanese are up to see "Six Personal Computers from Japan" by Christopher P. Kocher and Michael Keith, page 60, in this issue.)

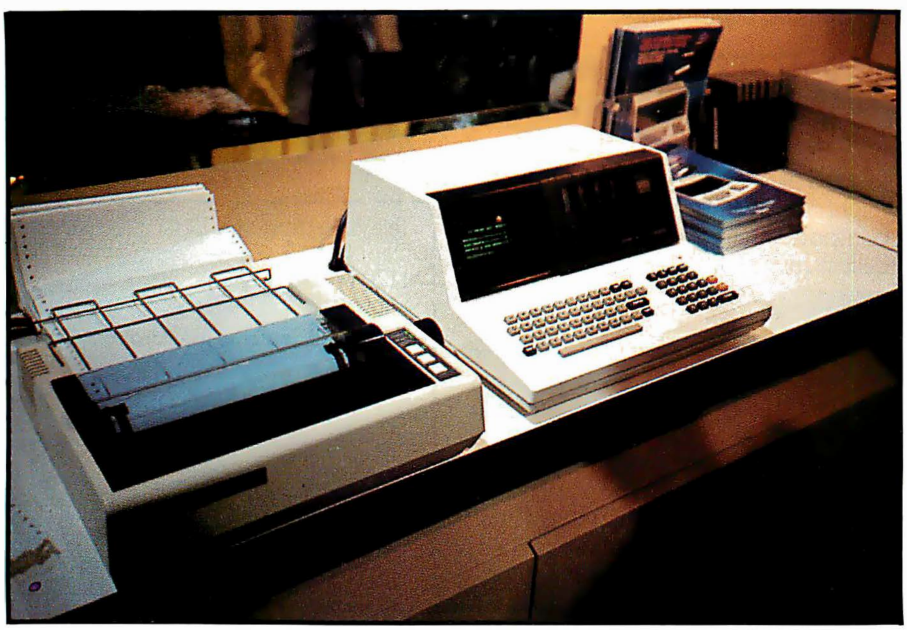
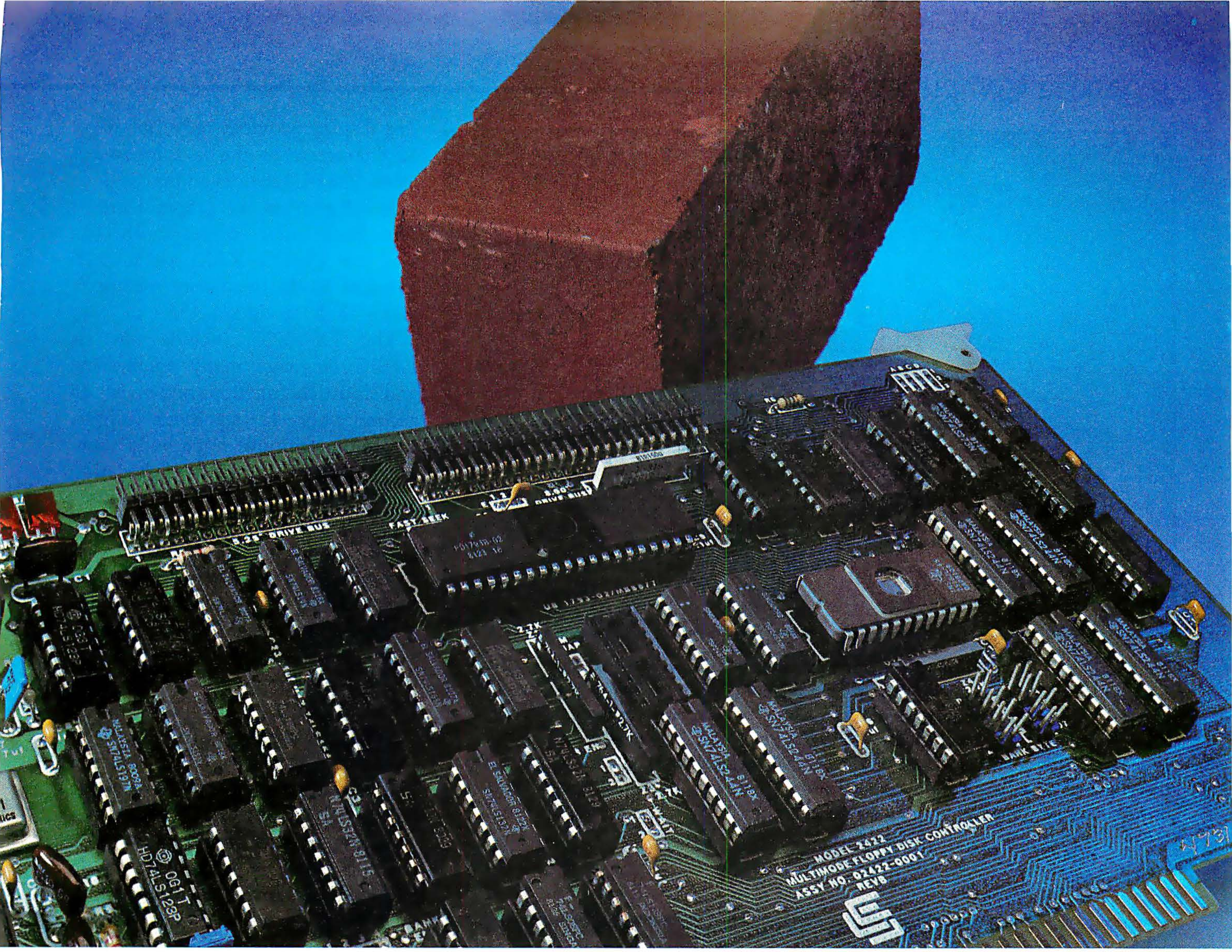


Photo 1: *Casio's FX-9000P personal computer was finally introduced at the January Consumer Electronics Show. Using a Z80 look-alike, the basic unit comes with 12K bytes of ROM and one 4K-byte CMOS RAM pack with battery backup. RAM is expandable to 32K bytes, and a 16K-byte dynamic RAM pack is also available. The button-type keyboard contains only 67 keys but allows one-key access to many scientific and statistical functions. The printer is manufactured by Epson.*

Casio's FX-9000P

Casio has finally released its FX-9000P personal computer (see photo 1) which is based on a Z80 look-alike microprocessor. Running at 2.75 MHz, Casio's proprietary processor is in a rather unique environment. Casio partitioned the user-memory area (32K bytes maximum) into 10 sections. The philosophy behind this decision is related to the way memory is physically added to the machine: in 4K-byte CMOS (complementary metal-oxide semiconductor) RAM (random-access read/write memory) packs with three-year battery backup. You can write programs to a RAM pack and interchange packs for different applications. While this may sound like a useful way of storing programs, keep in mind that each 4K-byte RAM pack costs $189. Compare this to the Bubcom80's $175 bubble-memory cartridges, each capable of holding 32K-bytes indefinitely, in a much smaller package.

The FX-9000P uses a button-type keyboard and is limited to 67 keys.



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Photo 2: *NEC's PC-6000 computer system was introduced recently in Japan and may be brought to this country soon. Shown here is the PC-6001 computer, the Touch Panel graphics tablet, and the data-cassette recorder. The keyboard on the unit shown is of the button type and allows use of an overlay, but NEC is contemplating the use of a keyboard similar to the one used on the PC-8001 before the PC-6001 is introduced into this country. The Touch Panel, expected to sell here for less than $200, would mark a breakthrough in low-cost graphic input devices.*



Photo 3: *A close-up view of the PC-6001 as shown at NEC's suite at the Riviera Hotel in Las Vegas. Though the keyboard is of the button type, the feel was very good and not at all toy-like. The gray area surrounding the keyboard is a removable overlay which is very useful in applications where it is necessary to redefine the keyboard. ROM packs can be inserted in the right side of the case, and the speaker opening is visible at the upper left-hand corner of the case. Both the style and layout of the keyboard may change before introduction of the PC-6001 into this country.*

The display provides only 16 lines of 32 characters in the text mode but offers 256 by 128 dots on the 5½-inch video display in the graphics mode. The basic unit comes with one 4K-byte CMOS RAM pack, 12K bytes of ROM (read-only memory), and a 4K-byte video RAM.

The FX-9000P includes in its BASIC language many engineering and statistical functions and boasts an accuracy of 12 significant digits. Trigonometric and hyperbolic functions, as well as standard-deviation and correlation-coefficient functions, are built in and can be accessed with single keystrokes. Powerful graphics commands let you easily plot points, lines, curves, and quadrangles, which are useful for a graphics representation of business and scientific data.

Two option boards provide expansion capabilities. The OP-1 ($379) attaches to the lower rear of the mainframe and contains a cassette-tape interface, clock, alarm, and calendar logic with battery backup, a character printer interface, and a graphics printer interface. Casio designed the graphics printer interface to connect with the Epson MX-82 (an enhanced version of the MX-80 which costs $1295) and the character printer interface for a yet-to-be-released exclusive character printer. The cassette interface operates at 300 bits per second (bps).

The OP-2, when released, will enable the FX-9000P to access two single-sided, double-density disk drives and will contain the disk operating system (DOS). The system includes an RS-232C interface.

Prices for the FX-9000P start at $1199. The 4K-byte CMOS RAM packs are $189, and a 16K-byte dynamic RAM pack is available for $129.

NEC to Introduce the PC-6000?

NEC displayed its PC-8000 computer system publicly at the show, but in its hotel suite, I had a private viewing of the PC-6000 system (see photo 2). Recently introduced in Japan, the PC-6001 is obviously aimed directly at Radio Shack's Color

Computer and Commodore's VIC-20 markets. It contains NEC's version of the Z80 microprocessor, 16K bytes of ROM containing a subset of the BASIC found in the PC-8001, and 16K bytes of RAM expandable to 48K bytes. Made to connect to a color television, the display provides 25 lines of 32 characters and is capable of producing multicolored graphics. You can insert a ROM pack in the right side of the unit (see photo 3), and two Atari-type (nonresistive) joystick inputs allow connection of joysticks or other devices. The system includes RS-232C and Centronics ports and can synthesize music.

The keyboard on the unit I tried was of the button type, similar to the Color Computer's but with a much better feel to it. For applications that redefine the keyboard, you can use a keyboard overlay. Before the PC-6001 is introduced in this country, NEC may change its keyboard to resemble more closely that found on the PC-8001, although with that design you couldn't use the keyboard overlay. NEC still hasn't finalized the exact keyboard layout. The PC-6001 could be expected to sell here for well under $500.

Of equal significance was NEC's new graphics tablet. Expected to sell for less than $200, the graphics tablet connects to both joystick inputs, using 6 of the 8 bits of input provided. With the pressure-sensitive surface, you can use practically any writing instrument to trace existing artwork such as maps, or you can create new art directly on the tablet. I also viewed NEC's data-cassette recorder for program and data storage.

Toshiba Enters Personal Computer Market

Toshiba commanded a lot of attention at the show with the preview of its new T100. Part of the same family as the T200 and T250, the T100 provides a 64K-byte Z80-based computer for less than $1000. In addition to the 64K bytes of user memory, the T100 (see photo 4) contains 32K bytes of ROM and a 16K-byte video RAM.



Photo 4: *Toshiba surprised everyone when it previewed the T100 at the show. Shown here with the optional flat liquid-crystal display, the T100 is Z80-based and contains 64K bytes of user memory, 32K bytes of ROM, 16K bytes of video RAM, and provision for 32K-byte RAM and ROM packs. Toshiba will be offering Wordstar, dBase II, and all of the Structured Systems Group software, as well as CP/M, when the unit is officially introduced at next month's National Computer Conference in Houston.*

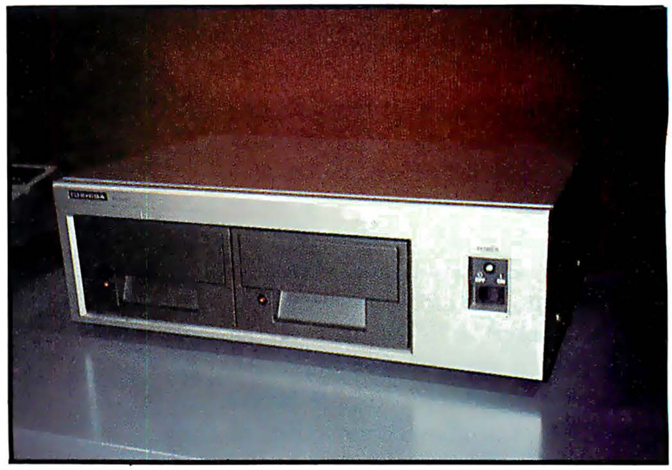


Photo 5: *The dual 5¼-inch floppy disk drive being offered by Toshiba for the T100 is housed in a sturdy steel case containing its own power supply. Each drive is capable of storing 280K bytes, and the basic T100 can support four drives.*

The ROM contains Microsoft BASIC, called T-BASIC, and CP/M is available. At the top right-hand corner of the unit, you can insert ROM and nonvolatile CMOS RAM packs with battery backup. Each pack can hold up to 32K bytes.

The T100 has a 90-key keyboard and displays 80 characters by 25 or 20 lines when used with a conventional monitor, or 36 characters by 24 or 19 lines when used with a regular television. Letters are formed in an 8 by 8 dot matrix. The color display can produce black, blue, purple, red, green, light blue, yellow, and white. You can display graphics in two modes: 640 by 200 dots and 160 by 100 dots.

One thing that caught everyone's eye was the optional flat liquid-crystal display, (see photo 4). The LCD pivot mounts on the back of the unit and displays 4 or 6 lines of 40 characters. It is also capable of providing a 320 by 64 dot matrix, which is dot addressable.

The T100 can accommodate up to four disk drives without resorting to use of the expansion unit (which will support four more drives). Two 5¼-inch drives, each capable of storing 280K bytes on a 5¼-inch floppy disk, are housed in a sturdy metal enclosure (see photo 5) which also contains a power supply.

The T300, an 8088-based unit operating under MP/M and supporting from one to four users, was not on display at the show but is scheduled to be at the National Computer Conference in June. Toshiba will sell the basic T300 for $1500 and a full-blown four-user system, employing a hard disk, for up to $20,000.

The T100's optional, flat liquid-crystal display caught everyone's eye. It can display 4 or 6 lines of 40 characters.

Rumors

Reliable sources indicate that NEC is about to introduce an 8086-based all-in-one computer that will employ Digital Research's CP/M-86. Although it's still unofficial, I wouldn't be surprised if NEC were to preview the unit at one of the national computer conferences in late spring or early summer. NEC in the past has used a similar approach of previewing its computers such as its PC-8000 system before officially announcing them as viable products on the U.S. market.

Hitachi is planning to introduce a 16-bit computer by year's end. Now being completed in Yokohama, the design will most likely include a 68000 microprocessor operating under the new CP/M-65K. Digital Research is developing this new version of its ubiquitous operating system for release in June. Hitachi considered incorporating the 8086 in its new machine, but the availability of CP/M for the 68000 assures Hitachi of a broad base of software.

More to Come

This by no means covers the range of computer products we can expect to see from Japanese manufacturers this year. Phil Lemmons's article "The Machines Behind the Machines" on page 114 in this issue will bring you up to date on who will be the driving forces behind these new products. The Japanese have been carefully studying the U.S. market and are clearly ready to step right in.■



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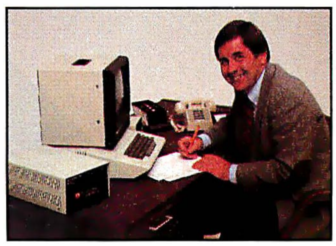
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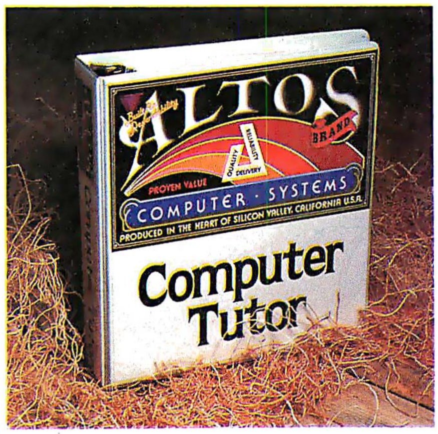
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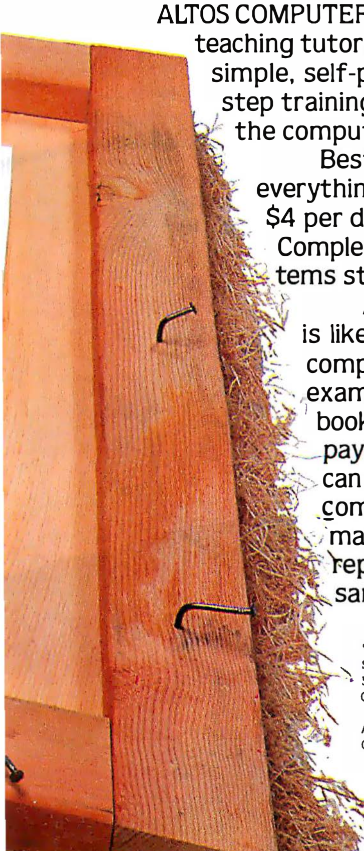
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Japanese Computers



The Machines Behind the Machines

Several Japanese companies, both large and small, have their eyes on the American market.

Phil Lemmons
Consulting Editor

When shopping for the products of any rapidly developing industry, you must judge not only the products themselves but also their manufacturers. This is especially true when products are complex. If you buy the world's greatest microcomputer from a company whose business acumen falls far below its engineering genius, that company may not be around two years from now when you need parts or service for the machine. You want to buy a machine from a company that will continue to produce and support microcomputers. When you buy, you're betting on one company to survive.

The temptation is strong to buy only from the largest companies, but that oversimplifies the judgment you must make. Size is, of course, important. Companies that hope to survive in the American microcomputer market must now be able to stand up to giants such as IBM, DEC, and Xerox. Big companies can also achieve economies of scale and further economies by making most or all of their products' components (which economists call *vertical integration*).

Just as important as a company's size, however, is its determination to continue making microcomputers. Industry pioneers such as Apple Computer Inc. will be formidable competitors because everyone believes their manufacture and support of microcomputers will probably continue. If some huge, diversified company introduces a microcomputer that fails to win a good share of the market, that company can stop making microcomputers and rely on its hundreds of other products.

This article doesn't pretend to judge the contenders in the battle for survival in the U.S. microcomputer market; it's purpose is to profile some Japanese companies, including Canon, Oki, Fujitsu, Hitachi, NEC, and Systems Formulate Corporation. (For a comparative review of these companies' microcomputers see "Six Personal Computers from Japan," page 60 in this issue.) To help you put this information in context, I'll first give some information about the microcomputer industry in Japan and about Japanese pricing policies in the United States. I'll close with a few speculations about Japanese microcomputers in the United States during the next two years. These speculations must be considered strictly amateur.

The Japanese Microcomputer Industry

The Japanese microcomputer industry is large and diverse, but two generalizations apply: the graphics are excellent, and the competition is fierce. The graphics are excellent because they *must* be in order to represent the complex kanji (Chinese characters) used in Japanese. The competition is fierce because manufacturing personal computers appeals to two different kinds of Japanese companies: the long-standing manufacturers of computers and the consumer electronics firms.

Sixty-four companies manufacture personal computers in Japan. (Sixty-

four; this is not a misprint. Clearly, the Japanese are finding ways to occupy the 40,000 electrical engineers who graduate from Japanese universities each year.) At least eleven Japanese companies are already marketing microcomputers in the United States: Canon, Casio, Seiko (Epson), Fujitsu, Nippon Electric Company (NEC), Oki (through BMC), Panasonic, Sharp, Systems Formulate, Toshiba, and Hitachi (the last delayed by the FCC's changes in rules governing radio-frequency interference). Sanyo and Sony are in the wings, and others are in their dressing rooms.

Computer Manufacturers

The *Japan Electronics Almanac 1981* lists six major manufacturers of computers in Japan: Fujitsu, Hitachi, NEC, Toshiba, Mitsubishi Electric, and Oki Electric Company. These companies have experience in developing integrated computer systems and software. Oki is by far the smallest with "only" 12,000 employees compared to Fujitsu's 34,000 and Mitsubishi's 49,000. NEC employs 64,000; Toshiba, 98,000; and Hitachi, 151,000.

We know less about the intentions of the Japanese consumer electronics manufacturers than we do about the major computer manufacturers.

Each of these major manufacturers has the resources to make a dream machine. The question is, can they effectively market their microcomputers in the United States?

Fujitsu has the least experience in consumer electronics and has shown a tendency to market its machines through OEMs (that is, to have its machines packaged and sold under the names of other original equipment manufacturers). NEC markets consumer products widely in Japan but not in the United States. On the other hand, NEC has outpaced the other companies in entering the American microcomputer market. Like NEC, Oki has also sold peripherals here, notably its Okidata printers, and is marketing small-business computers through the Japanese trading company BMC (Business Machines Corporation) and BMC USA Inc., its American subsidiary.

Various sources claim that 8086- or 8088-based microcomputers will come from Toshiba, NEC, Hitachi, and Fujitsu. If these rumors are true,

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The Japanese Manufacturers—How Successful Will They Be?

by Tod Zipnick
TMQ Software Inc.
390 Northeast River Rd.
DesPlaines, IL 60016

America has long awaited the Japanese entry into the U.S. personal computer market. Some Japanese companies have already begun to sell microcomputers here, and more are surely on their way. But a few questions remain unanswered: How successful will the Japanese companies be? What are their plans and what products can we expect from them?

Japanese companies will have to go through a two- to three-year learning curve to understand the American microcomputer market. For one, Japanese methods of conducting business are different from ours. As well, they might encounter problems stemming from a less than thorough understanding of microcomputer distribution, service, and support, FCC regulations, and software and its support.

Japanese Methods of Conducting Business

When Japanese engineers consider the design of a new product, they accept advice mainly from divisions within their company that have been successful in the past. Because their experience at this point stems from the Japanese rather than the American marketplace, new products are often designed with Japan in mind, not America. The market for microcomputers in Japan is several years behind ours. This explains why one Japanese company can plan to release a cassette-based microcomputer with no means to interface it with a disk drive. The Japanese market will accept such a product, but the same product will find much resistance in America.

Japan is several years behind us in software capability. They know hardware better than software. Japanese products reflect this lack of knowledge; consequently, their computers are hardware-intensive rather than software-oriented. The hardware is, nonetheless, very good.

Distribution, Service, and Support

Microcomputer distribution, service, and support are also different here. The Japanese marketplace still contains a lot of hobbyists, and only recently in Japan has there been a transition to the business marketplace—a transition we experienced several years ago. When an American business plan is presented for Japanese approval, the Japanese are naturally skeptical about the distribution, service, and support based on their experiences in Japan. They do not yet understand the amount of money needed to support these functions in the American marketplace.

FCC Regulations

Having to pass a microcomputer through the FCC for approval is a new experience for the Japanese. Because of this, the Japanese manufacturers will spend a lot of time getting approval for their first line of products. In an industry that moves as fast as this one, such a delay could hurt their marketing plans. Future designs for new products will undoubtedly be passed through more quickly.

Software

One of the biggest lessons the Japanese companies will have to learn is that software sells hardware in America. A Japanese company will look at the third-party support of the Apple, Atari, Radio Shack, and IBM computers and expect the same to occur for their machines. What they may not realize is that they will have to commit $1 to 3 million to acquire software applications from outside vendors to do the job properly. A lot of money needs to be poured into software evaluations and support of software when it is released. This must be done in America, not in Japan, because the people working in Japan are not aware of the software options available through companies in the United States. At this time, very few Japanese companies have allocated the necessary resources in America to carry out these steps.

For software development, Japanese companies must lend between 50 and 100 machines to software companies. This often adds up to more money than most Japanese companies at first realize is necessary to push a product onto the market. Technical documentation on a system is also very difficult to get from Japanese manufacturers. The time and money needed to produce these documents is a must if software companies are going to support a machine.

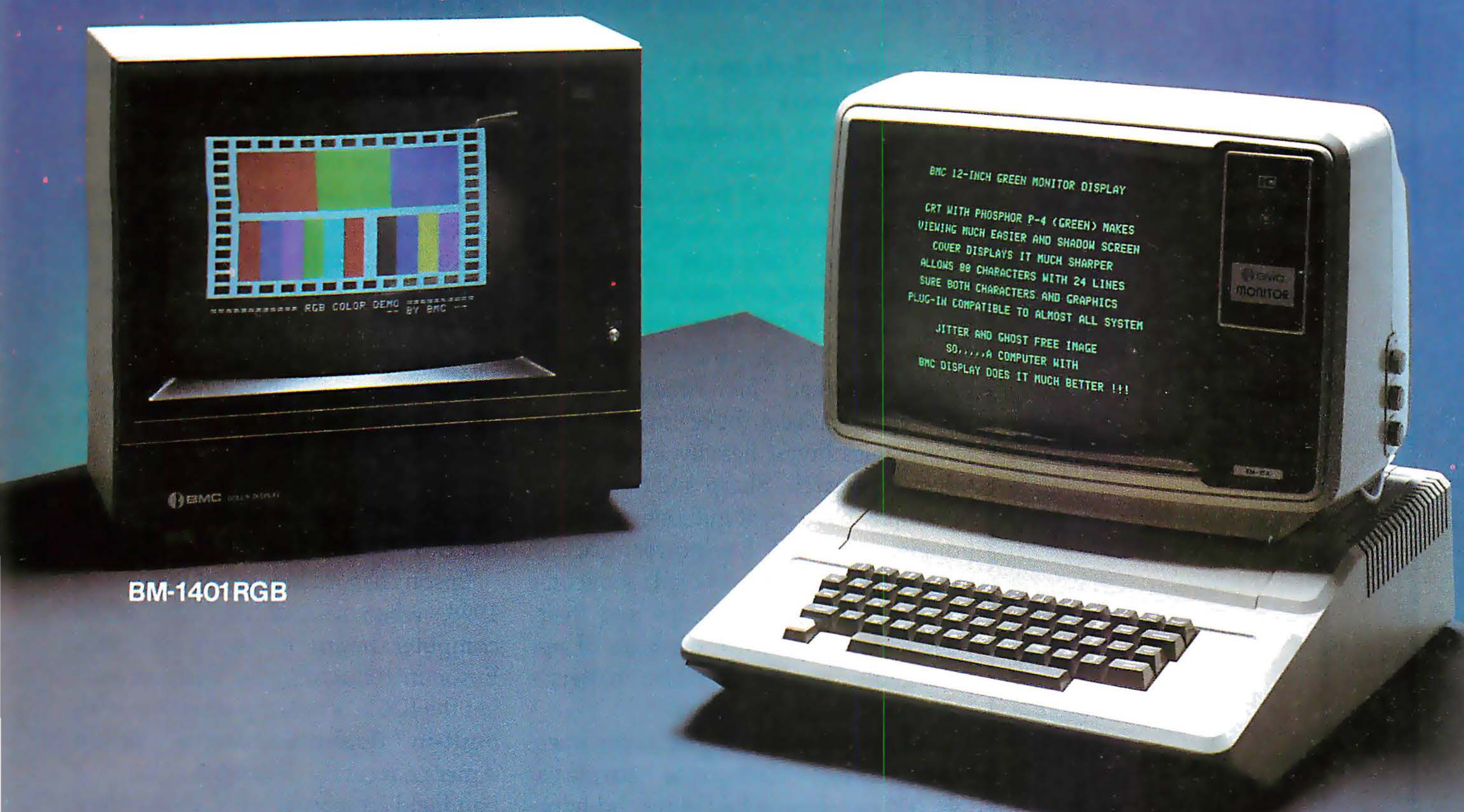
We can expect Japanese manufacturers to make many mistakes when they first enter the American market. Remember, however, that American manufacturers had similar problems in the past. As the Japanese learn, and if they remain committed to the U.S. market, we can expect to see some fine products from Japan in the future. ■

About the Author

Tod Zipnick is president of TMQ Software, a Chicago-based software and consulting firm to the microcomputer industry.

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the Japanese computer companies seem to be swarming around the chips of Intel design. This phenomenon is probably based on a desire to capitalize on the large base of software that already exists for these products.

Only Toshiba, NEC, and Hitachi are significant manufacturers of both computers and consumer products. Only Toshiba and Hitachi have marketed their consumer products on a large scale in the United States.

Consumer Electronics Manufacturers

Sharp, Sony, Matsushita (Panasonic and Quasar), Casio, Sanyo, Seiko, and Canon have all been successful in marketing consumer electronics in the U.S. These companies know the American consumer market and have impressive distribution and service networks. The demands of the consumer markets for small battery-powered gadgets have made these companies invest heavily in semiconductor research. Sharp and Seiko, for example, have spent millions on developing advanced low-power CMOS (complementary metal-oxide semiconductor) chips. Those chips and their descendants will form the basis of remarkably small, portable, battery-operated microcomputers.

As to the sizes of the companies themselves, Matsushita employs 96,000 people and had semiconductor sales of $254 million in 1981 (double the sales of Texas Instruments). Sony employs 33,000 and has annual sales of around $5 billion, Sanyo employs 19,000, and Sharp employs 18,000. Canon is a $2-billion company. Seiko is a privately held $3-billion company.

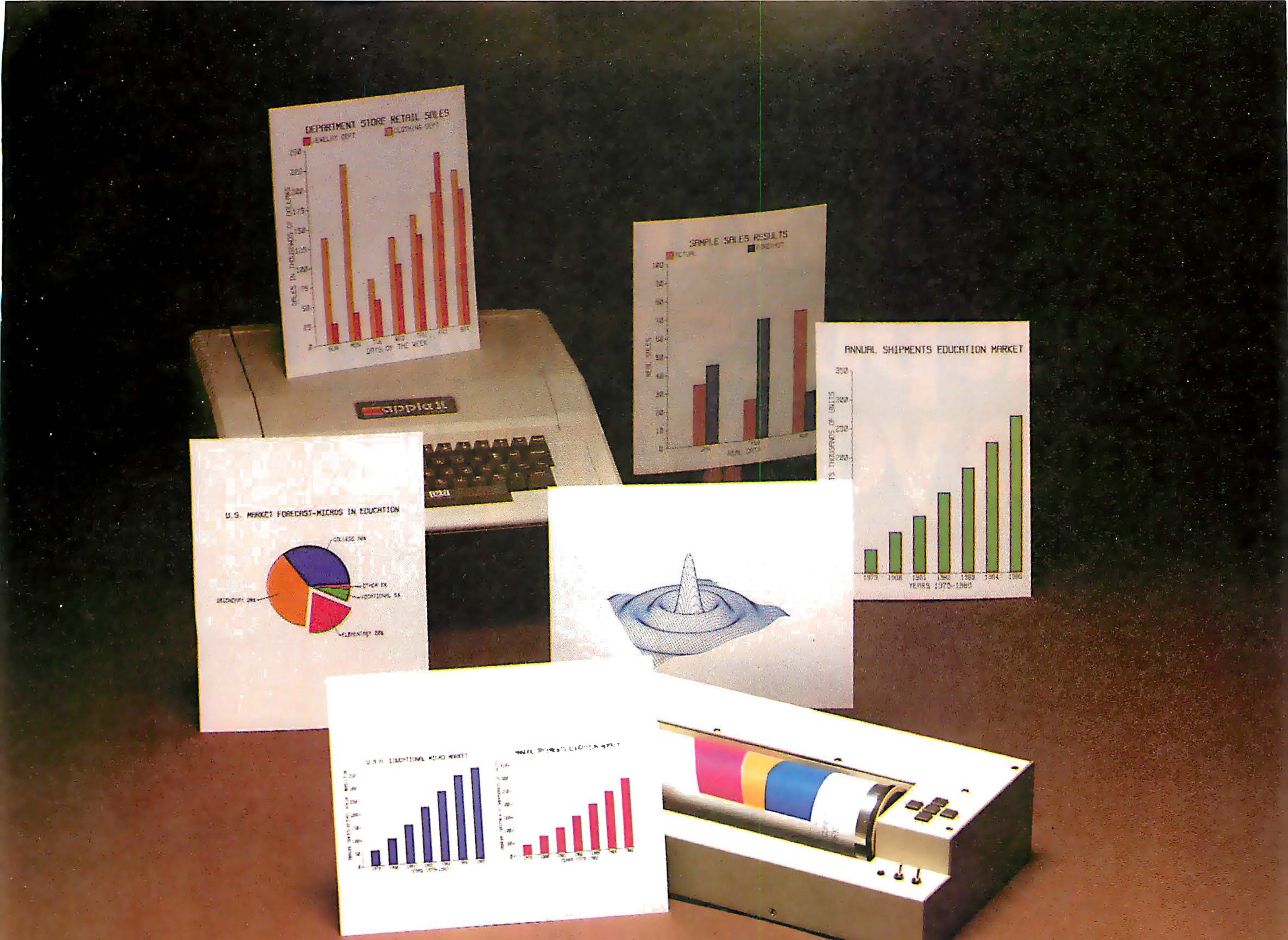
We know less about the intentions of the Japanese consumer electronics manufacturers than we do about the major computer manufacturers, but the consumer electronics companies are clearly interested in the American microcomputer market. Sharp makes the YX-3200 business-oriented computer, a handheld computer, and also manufactures the handheld computer sold here under the Radio Shack name. Casio makes and sells the FX-9000P, a desktop microcomputer aimed at scientists and engineers. Matsushita is producing a 6502-based handheld computer for sale under both the Panasonic and the Quasar names. Sony offers its Typecorder and a word processor that uses 3-inch floppy-disk drives. Matsushita and Hitachi are making 3-inch floppy-disk drives too.

Japanese consumer electronics companies know what an important role convenience of use plays in the sale of consumer goods. If we're lucky, these companies will introduce microcomputers that are not just friendly to users but are downright seductive.

Of particular interest to current microcomputer users is the Suwa Seiko Group, maker of Seiko watches. Suwa Seiko established the Shinshu Seiko Company Ltd. in 1961 to make watch parts. Shinshu Seiko now makes small liquid-crystal displays and digital printers. In the U.S., we know Shinshu Seiko better under the brand name Epson, as in Epson MX-80, the matrix printer that took the U.S. by storm.

Epson has made computers since 1978, when sale of the EX-1 office computer began in Japan. In 1980, Epson introduced to the Japanese market the KX-1, a desktop computer with built-in dual-disk drives. Epson America recently showed the HX-20, a handheld computer that looks very much like the Sony Typecorder, in the United States. At the October 1981 Data Show in Tokyo, Epson exhibited a desktop personal computer, the QC-20, which runs CP/M, has a 4-MHz Z80 processor, and comes with up to 256K-bytes of RAM (random-access read/write memory). The Data Show also gave Epson the opportunity to introduce a slim-line, 5¼-inch floppy-disk drive called the FT-20. Look for Epson to do big things with small packages.

Sony's plans for microcomputers are unknown, but in researching this article, I talked with many executives from Japanese electronics companies in the United States. Three people told

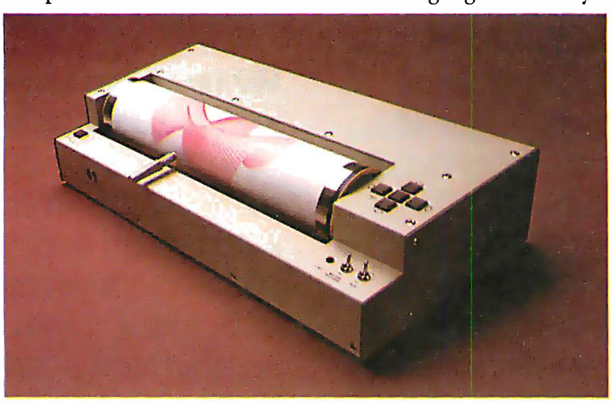


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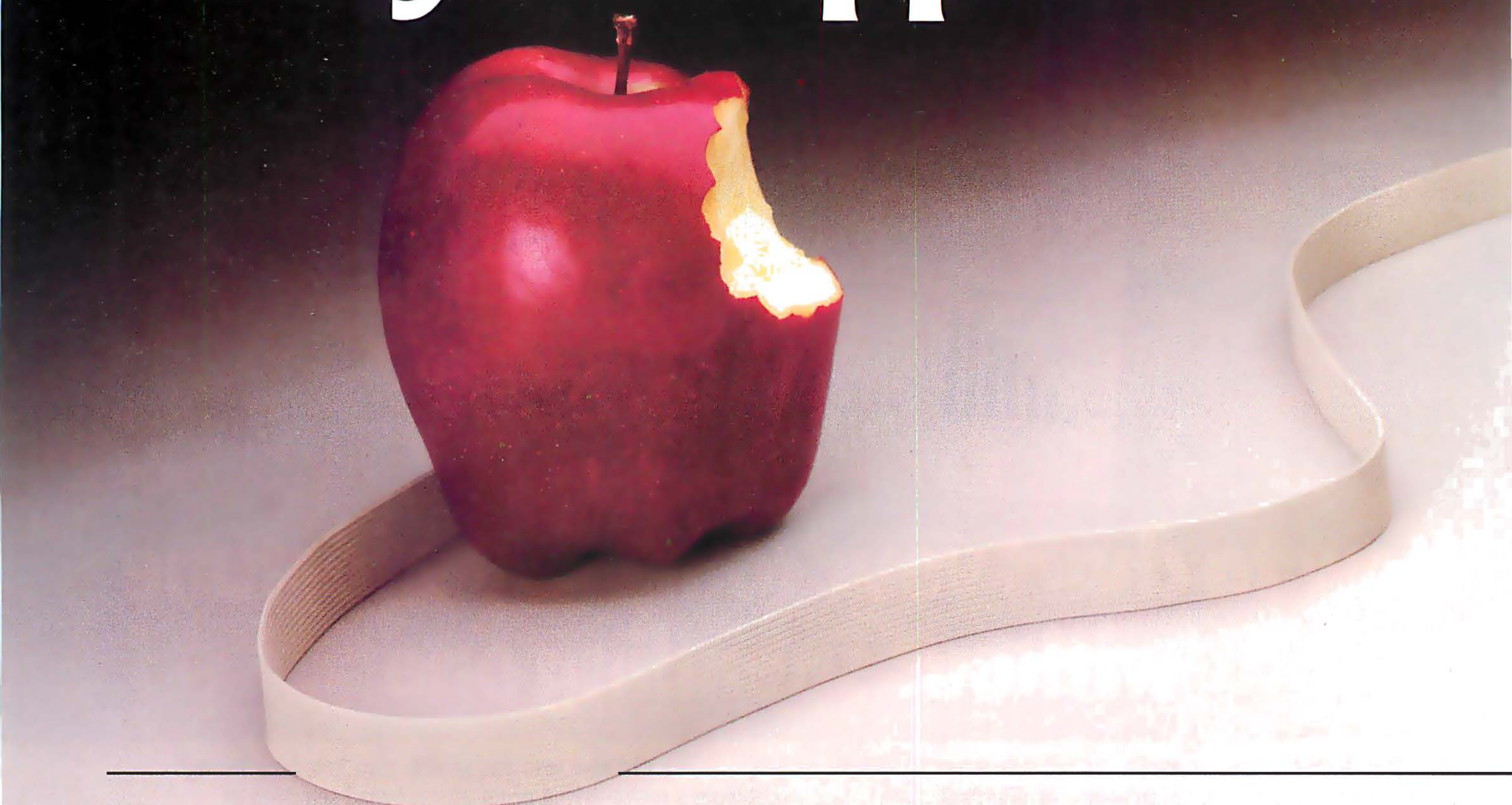
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me that Sony has a marvelous personal computer running. Two of these sources said that the Sony computer is based on the 8086 microprocessor. One of these sources said that Sony had not yet decided to market the computer. Another enticing report claims that Sony is developing a 3-inch Winchester hard disk.

Matsushita will soon introduce a floppy-disk drive module for its handheld computer. The module incorporates a Z80 microprocessor and runs CP/M. Last fall at the press conference introducing the handheld computer, a Panasonic spokesman said, "This is only the beginning."

An Exceptional Entry

Among the Japanese microcomputers reviewed in this issue is the Bubcom80 from Systems Formulate Corporation. This small company, recently founded with Fujitsu's help by a former designer for Fujitsu, is neither a consumer electronics manufacturer nor a major computer manufacturer. Systems Formulate is, however, entirely devoted to designing and selling microcomputers and to teaching people how to use them. In addition to its own Bubcom80, Systems Formulate sells the Commodore VIC, the NEC PC-8001, the Apple II, and the Oki if800. A more detailed profile of Systems Formulate appears later.

Japanese Pricing Policies

Some American advertisements are welcoming the entrance of the Japanese into the microcomputer market here. Other voices, however, are warning that the Japanese will use unconscionable pricing policies to drive their American competitors out of the market.

American semiconductor manufacturers reportedly feel that Japanese manufacturers are "dumping" integrated circuits in the United States. That is, they're selling at a loss in order to drive American companies out of the market. The Japanese maintain that they are selling at a small profit despite paying a 4.2-percent tariff.

Chris Rutkowski, marketing and national sales manager of the peripheral products division of Epson America, offers a strong rebuttal to charges that the Japanese practice unfair pricing. Rutkowski sums up the difference between the way American and Japanese companies price their products with: "The Americans make a product and sell it for as much as they think they can get. The Japanese make a product and then figure out what it actually cost to make and distribute it. Then they add 15 percent. This is fair, equitable pricing."

American car advertisements on television are now verging on racism. While it's convenient for the American auto industry to blame the Japanese for plummeting sales, most consumers realize that Detroit is in trouble mainly because its executives were appallingly slow in realizing the need for small, efficient cars.

The American microcomputer industry seems far more progressive than the car industry. American microcomputer manufacturers expect a challenge and are preparing to meet it—I hope—without resorting to slurs. It seems reasonable to expect that fair competition between domestic companies and the Japanese in the American microcomputer market will lead to better products and lower prices, with several companies surviving on each side and the American consumer being the ultimate victor.

BMC

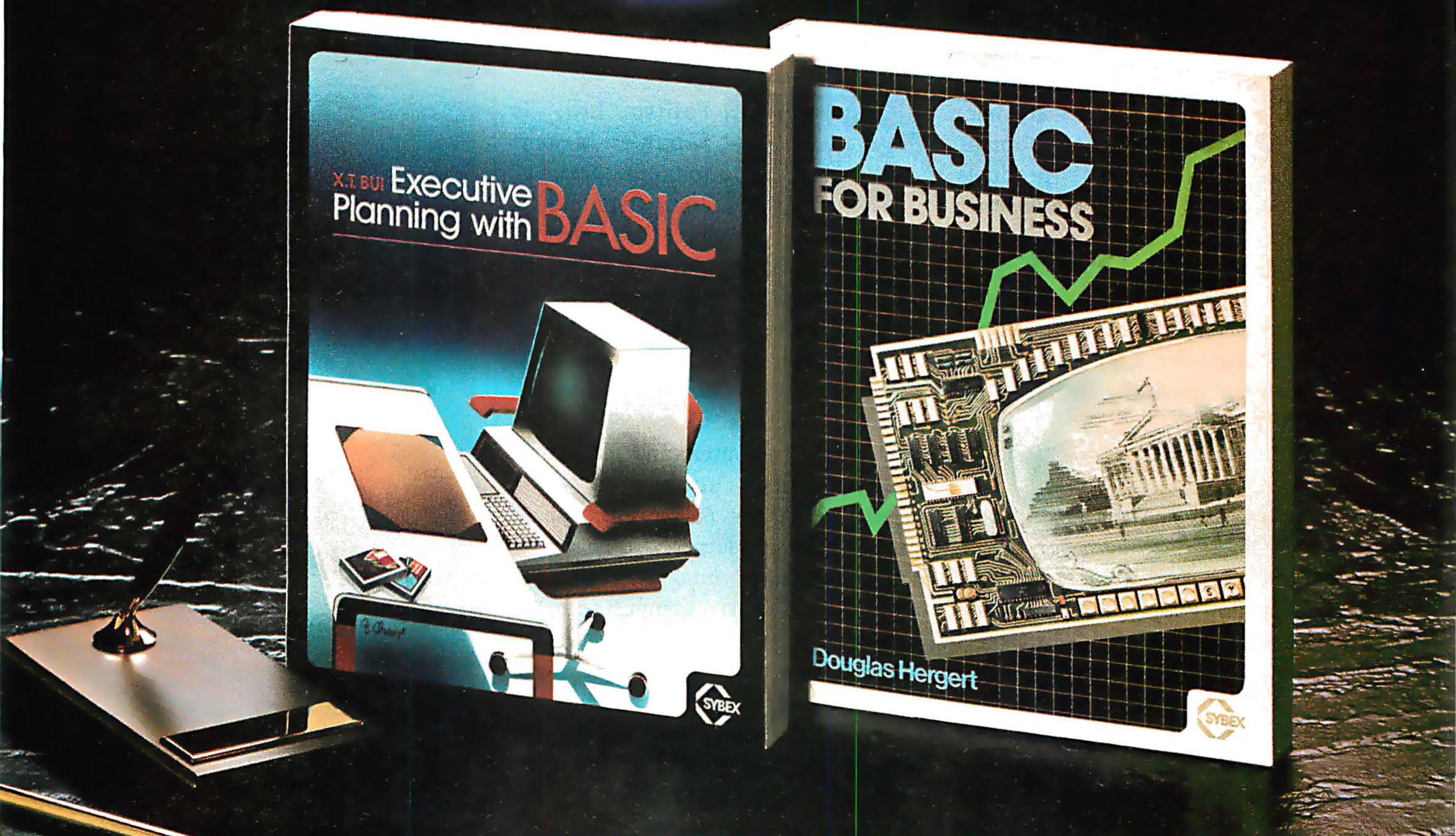
BMC International is a Japanese trading company founded in 1977 to specialize in electronic products. BMC sells video monitors and terminals, memory boards, electronic typewriters, printers, the Oki if800 microcomputer, calculators, electronic games, and other products based on integrated circuits. BMC's promotional literature mentions personal computers as well as business computers. Its American subsidiary is known as BMC USA, Inc.

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Oki Electronics of America, Oki Semiconductor, and Oki Electric Overseas Corporation are other subsidiaries of Oki Electric Industry. Last year marked Oki's centennial. While the company's size doesn't rival that of giants such as NEC and Toshiba, Oki does devote all the efforts of its 12,400 employees to electronic and telecommunications equipment.

About 38 percent of its sales consist of electronic business machines. Oki's OKITAC series of computers sells well in Japan, as do Oki's modems and teleprinters. Okidata printers are popular here. Oki Semiconductor's products include 64K-bit RAM chips and other VLSI (very large-scale integration) chips. The company's new VLSI plant opened in 1981 and was producing 3 million 64K-bit dynamic RAMs a month by late 1981. Oki expects production to rise gradually to 10 million a month by 1985.

Canon Although better known for calculators and cameras than for computers, Canon is capable of mounting a substantial microcomputer marketing effort in North America. Canon has diversified in recent years and now produces copiers, electronic typewriters, micrographics equipment, magnetic-card readers, magnetic heads for audio and digital devices, and microcomputer disk drives. Canon is conducting research in computer-aided design (CAD) and computer-aided manufacturing (CAM). In fact, 40 percent of Canon's sales in North America are business machines.

The two primary markets for microcomputers are home and office, and Canon USA has extensive experience in North America in both. So far, Canon has produced computers for the office market only. The Canon CX-1 and the BX-3 are general-purpose small-business computers.

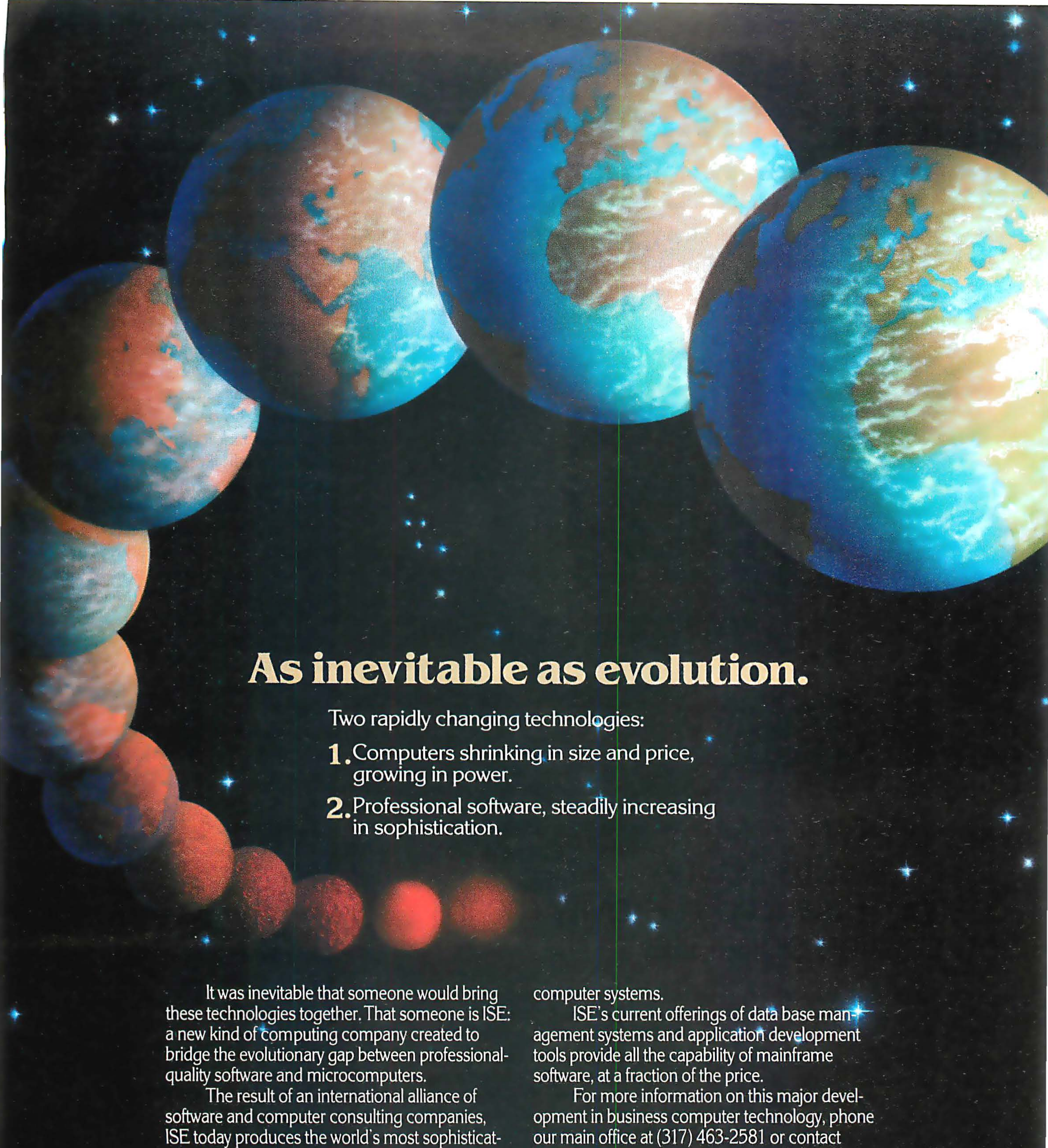
The TX-10 and TX-15 are designed for fields such as banking and finance, payroll management, foreign exchange, science, statistics, insurance, real estate, and auto sales. The TX-10 has a numeric pad, and the TX-15 has a standard alphanumeric keyboard. The TX-25 has an alphanumeric keyboard and 4-inch floppy-disk drives. All these machines are based on the Motorola 6809 microprocessor. Canon could seek a larger market through its 7500 independent dealers in the United States and Canada, and its 700 authorized service centers could be a strong selling point for consumer computers.

FUJITSU Fujitsu Ltd. is Japan's largest manufacturer of computers and its fourth-largest producer of semiconductors. Although Fujitsu's assets of $3 billion are less than those of a few other Japanese corporations, Fujitsu devotes most of its efforts to computers and data communications. In fact, of Fujitsu's $2,769,895,000 in 1981 sales, computers and data communications accounted for $1,819,495,000 or 66 percent. Fujitsu makes printers, large hard-disk systems, terminals, integrated circuits, and many other computer-related products.

Fujitsu's prowess in making large computers is widely recognized. In May 1981, Fujitsu introduced the world's most powerful general-purpose computer, the FACOM M-382. Its dual processor system has 32 to 128 megabytes of main storage and as many as 64 channels, for a maximum total throughput of 96 megabytes per second.

Fujitsu is one of the world's largest producers of integrated circuits; its 64K-bit dynamic RAM mass-production system *is* the world's largest. Fujitsu sells integrated circuits in the United States through the subsidiary Fujitsu Microelectronics. In development are high-electron-mobility transistors (HEMT) and Josephson-junction elements, both of which should bring dramatic improvements in circuit performance.

No one is doing more with bubble memories than Fujitsu. Mass production of 64K-bit and 256K-bit bubble



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memories will begin soon, and Fujitsu has developed a prototype 1-megabit bubble memory. Although Fujitsu foresees the use of bubble memories in personal computers, price seems an obstacle at present.

In the U.S., Fujitsu markets its small- and medium-scale computers via the TRW-Fujitsu Company, a joint venture with TRW Inc. Fujitsu exports its large-scale computers to Amdahl Corporation, which markets them in an OEM arrangement.

In the realm of microcomputers for the mass market, Fujitsu has yet to establish itself. Fujitsu's "piggy-back" microcomputers, with their detachable ROMs (read-only memories) are certainly innovative. Users find the ease of replacing these ROMs a great aid in program development. The Fujitsu Micro 8 (FM-8), with twin 6809s and an optional Z80, is impressive too, although we have lately learned that it will not be sold in the U.S. in its present form. Fujitsu is among the Japanese firms rumored to have 8086-based systems in development, but they're not expected to be unveiled this year.

HITACHI Hitachi is a 70-year-old corporation whose 151,000 employees turn out thermal, hydroelectric, and nuclear power equipment as well as other electric utility equipment; chemicals; iron, steel, wire, and cable; industrial machinery; consumer products including televisions, video-tape recorders, audio equipment, and air conditioners; and computers, semiconductors, and other electronic equipment. Consumer items accounted for 21.3 percent of 1980 sales; computers, semiconductors, and other electronic equipment accounted for 18.9 percent. Hitachi's Maxell floppy disks have a substantial share of the market here and a reputation for excellent quality. Hitachi's dynamic RAMs also enjoy a good reputation, including the 64K-bit chips. In 1981, Hitachi was Japan's second-largest producer of semiconductors, turning out $614 million worth of chips.

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CP-202C

Hitachi's integrated circuits and computers have been selling well where marketed under Hitachi's own name. Domestic Japanese sales of Hitachi's M and L series computers have been brisk. Hitachi's M-280H is among the world's most powerful computers, with 32 megabytes of main memory. What better place to dump that much data than the Hitachi disk storage unit that holds 2.5 gigabytes? The HITAC E-800 is a formidable super minicomputer, and the HITAC L series is designed for use as terminals in distributed processing. At the smaller end of the size scale, Hitachi offers three microcomputers based on the 6809 processor; the MB-6890, reviewed in this issue, is the most powerful of the three.

Despite its size, technical excellence, and vertical integration, Hitachi has suffered some setbacks in foreign markets. Hitachi was supplying processors to Itel in the United States, and Itel's debacle in computers hurt Hitachi here. In response, Hitachi has signed an agreement to supply large processors to a National Semiconductor Corporation subsidiary, National Advanced Systems Corporation. Hitachi has a similar arrangement in Europe with Olivetti.

The FCC's radio-frequency interference rules postponed the Hitachi 6809-based machines' entry into the American market. Hitachi is showing signs of being unhappy about software support for its 6809-based systems and is considering basing its future microcomputers on the 8086. Whatever Hitachi's decision, this giant company can make anything it wants to make, and it is sure to make interesting microcomputers.

NEC

Nippon Electric Company is another of the Japanese corporate giants on the international scene. With 64,000 employees and $5,174,493,000 in assets in 1981, NEC produces consumer products, including color televisions, hi-fi audio equipment, and kitchen appliances; microcomputers such as the PC-8000 series; and minicomputers such as the Astra series. It also produces mainframes, including the NEC System 1000, which can execute 29 million instructions per second, has a 64-megabyte main memory, a 256K-byte high-speed cache memory, and excellent integrated circuits, including NEC's widely used 64K-bit dynamic RAM chips (256K-*byte* dynamic RAMs and 512K-bit ROMs are in the experimental stage).

NEC's long list of peripherals is headed by the excellent Spinwriter series of letter-quality printers, renowned RGB (red-green-blue) color monitors, matrix printers, band printers, modems, floppy disks, and Winchester hard disks. In 1981, NEC led the world in production of semiconductors with sales of $805 million, about seven times those of Texas Instruments.

NEC clearly has everything needed for vertically integrated production of microcomputer systems. Moreover, much of its strength is in computers (24 percent), electronic devices (23 percent), and home electronics (13 percent).

Two of NEC's subsidiaries are now selling the PC-8000 series in the U.S. NEC Home Electronics USA, Personal Computer Division, targets the personal-computer market, while NEC Information Systems Inc. sells to the small-business market. NEC Information Systems also offers office furniture designed for the PC-8000 and a new communications board for the PC-8000 in the office environment. Since its inception in 1977, NEC Information Systems has grown to an annual revenue rate of $100 million.

Indications are that both NEC Home Electronics and NEC Information Systems plan aggressive expansion. NEC exhibited two new 8-bit microcomputers in Japan last year. Reports suggest that NEC Home Electronics will bring out a computer (perhaps the PC-6000) to compete head-on in price with the Commodore VIC.

NEC Information Systems may introduce the PC-8800, which will represent an improvement in mass storage

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Japanese Computers

and packaging over the the PC-8000. The 8800 is expected to have 8-inch drives, and, unlike the PC-8000, the whole system can be turned on and off with a single switch. Both NEC Home Electronics and NEC Information Systems are offering more applications software tailored to the PC-8000.

Rumors are also circulating that NEC will introduce a 16-bit microcomputer based on Intel's 8086 microprocessor, but it's unclear whether the machine's target is home, office, or both. If and when NEC does introduce the 8086-based machine, much will be determined by which subsidiary introduces it—NEC Home Electronics, NEC Information Systems, or both.

Akio Watanabe founded Systems Formulate in September 1978. Since 1964, Watanabe's true love has been small computers. While a hardware designer at Fujitsu, he designed the FACOM 230 and FACOM V series systems. Watanabe struck out on his own in 1978 in order to spread the benefits of microcomputers to the public. Systems Formulate not only designs and sells machines but also provides training courses.

Sales from April 1980 to March 1981 were $4,300,000, up from $3,100,000 the previous year. Systems Formulate has already made a full return on its original investment of $230,000. Fujitsu president Taiyu Kobayashi helped Systems Formulate with technology and personnel as well as financing.

Perhaps the most striking fact about Systems Formulate is that it sells 8 to 10 percent of all the personal computers in Japan. Systems Formulate has four retail stores, three in Japan and one in Palo Alto, California. The systems sold include the Commodore VIC, the Apple, the NEC PC-8001, and the Oki if800.

Systems Formulate has two training "campuses," both in Japan. The campuses, which offer a variety of software training courses, provide a separate personal computer for each student. The most popular course? "SB nyu-mon," the beginner's course in small-business computer applications. Students can rent computer time for study outside class hours.

Watanabe and other Systems Formulate staff members designed the Z80-based Bubcom80, which Fujitsu builds. The Bubcom80 is a beautiful machine, and a drop in the price of bubble memory would make it hard to resist. Systems Formulate's direct retail sales of computers may enable the company's talented designers to understand better than others the needs of personal computer users. Add to that the little company's close ties with Fujitsu and apparent ability to use the giant's production facilities, and Systems Formulate seems an attractive dark horse in the American microcomputer market. At this point, however, Systems Formulate's only machine is too expensive for all but a few personal computer users.

TOSHIBA A century-old, $9-billion company that employs almost 64,000 people, Toshiba offers products that range from light bulbs to a neutral-beam injector for fusion experiments. Perhaps most impressive about Toshiba as a contender in the U.S. personal computer market is that Toshiba combines experience in both consumer electronics and information-processing systems with the capacity for vertical integration. Toshiba is Japan's third-largest producer of semiconductors, with sales of $541 million in 1981.

Toshiba's technological feats include a pocket liquid-crystal-display television, a voice-driven word processor for the intricate Japanese language, a highly successful family of CMOS integrated circuits, and the world's first microcomputer that uses silicon-on-sapphire (SOS) technology.

The first two microcomputers Toshiba introduced in the United States were its T200 and T250 desktop machines. Both use the 8085A microprocessor and come with CP/M, CBASIC II, and Microsoft BASIC

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standard. The T200 has two 5¼-inch built-in disk drives, and the T250 has two 8-inch built-in disk drives.

At January's Consumer Electronics Show in Las Vegas, Toshiba surprised everyone by showing a third microcomputer, this one using a Z80A processor. Called the T100, this model has BASIC in a 32K-byte ROM, 64K bytes of user RAM, 16K bytes of video RAM, and the capacity to accept two additional 8- to 32K-byte ROM or RAM packs containing languages or applications programs. The T100's price starts at less than $1000 and demonstrates the seriousness of Toshiba's interest in the American personal computer market. The T100 may or may not be the same machine as the rumored Toshiba PASOPIA. The PASOPIA was supposedly based on the 6502 processor and was to be priced below the Apple.

Toshiba will introduce another microcomputer at the June National Computer Conference in Houston. The T300 uses the more powerful 8088 microprocessor and is aimed at the small-business market. A single-user system with dual 8-inch, slim-line disk drives may sell for as little as $3500, with a 10-megabyte Winchester hard-disk drive costing perhaps $4000. A multiuser system consisting of four T300s, a Winchester drive, and a printer may sell for around $25,000.

All of a sudden, Toshiba has covered the entire spectrum of the American microcomputer market. Its products range from home computers for under $1000 to multiuser systems for $25,000. The T100, T200, T250, and T300 together seem to reflect excellent long-range planning. According to Toshiba, all four machines will run the same software. There may also be a 6502-based PASOPIA in the works.

Toshiba has signed 30 dealers and has a goal of signing 40 more this year. It has also opened two retail computer stores, one in the Westwood section of Los Angeles and the other in Costa Mesa, California. Vice-president and general manager John Rehfeld of Toshiba America stresses that the retail stores will serve as "learning laboratories for gathering information which can be useful to our dealer network."

Speculations and a Pipe Dream

At the moment, it looks as if NEC and Toshiba are leading the pack in marketing Japanese microcomputers in the United States. Expect them to maintain their lead for some time. Both companies will soon be offering complete lines of microcomputers ranging widely in price. Both seem determined to win a significant share of the American market. Both have the resources for large-scale, vertically integrated manufacturing. Toshiba has marketed more consumer products here, but NEC has established dealer networks for its Spinwriters and video monitors and, to some extent, for its PC-8000 series.

Later this year or early in 1983, Hitachi can be expected to introduce in the U.S. a series of powerful microcomputers. Despite its setbacks in marketing computers here, Hitachi is such an impressive company that its products are likely to be worth the wait. Hitachi has successfully marketed consumer products in the U.S. and has everything necessary for vertically integrated production. The only questions are whether Hitachi will decide to build the right machines and whether the market will still be waiting by the time the Hitachi machines arrive.

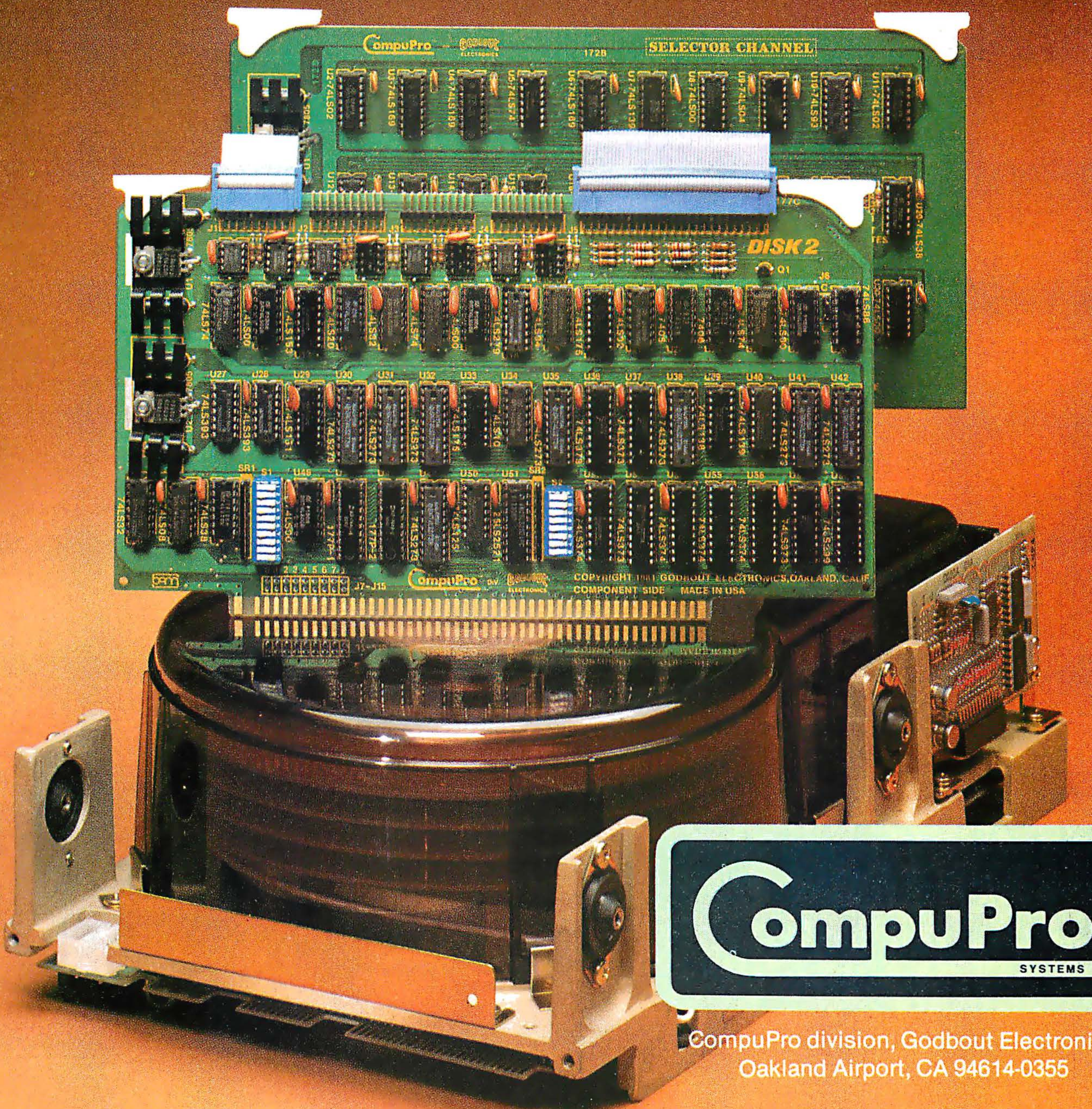
As for the consumer electronics companies, Seiko's Epson subsidiary will probably be the first to make a strong showing. Existing marketing channels and consumer enthusiasm for the MX-80, along with Seiko's state-of-the-art CMOS technology, enormous financial resources, and experience in manufacturing microcomputers, give Epson an excellent chance of winning a significant share of the American market. This is certain if Epson decides to sell its computers, as it does its printers, for very low prices.

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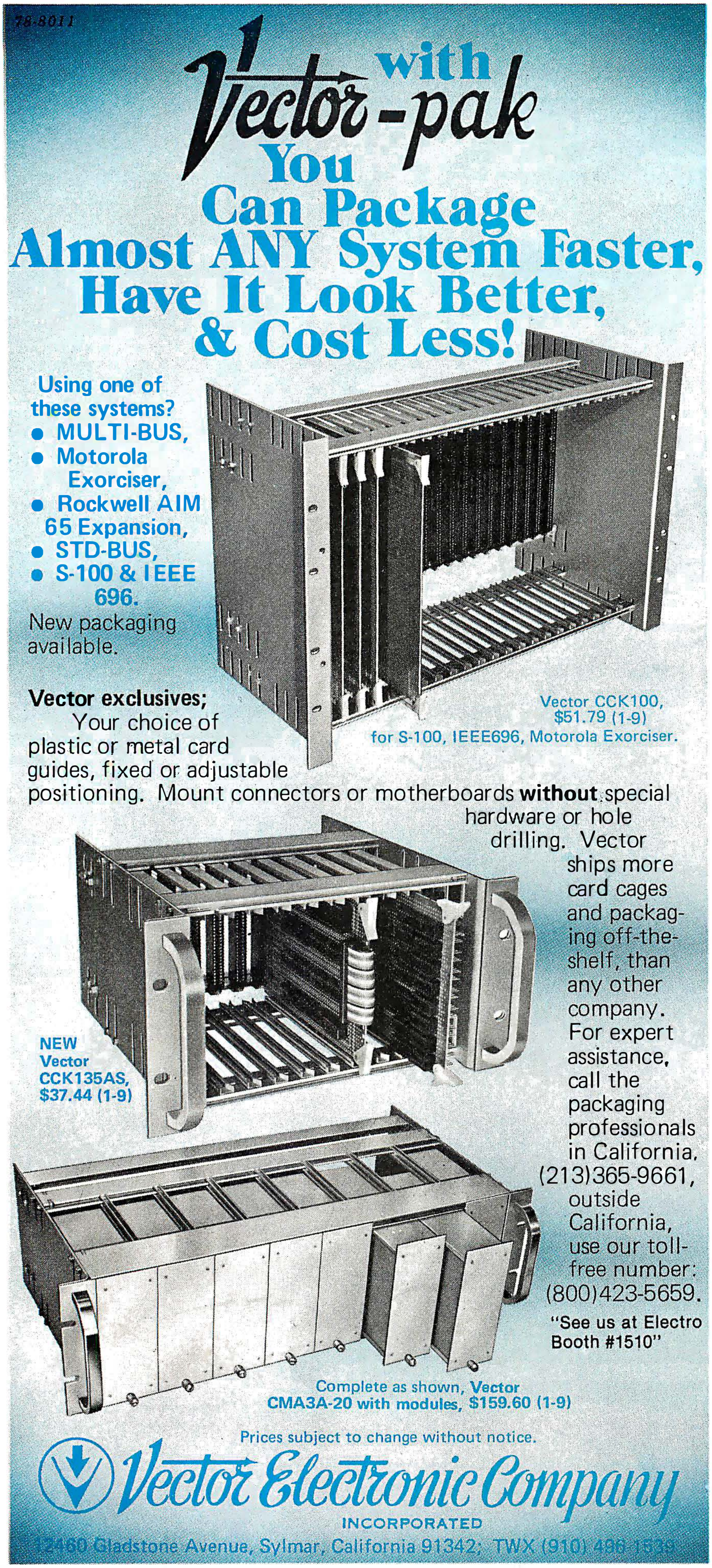
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computers that will set new standards for ease of use. The marketing channels open to these two companies are so extensive that both can easily recover from a late start.

The challenge to these companies is to design and produce the right machine on the first try. If the machines sacrifice versatility and performance to achieve the kind of compactness that fits neatly on one corner of a coffee table, then Sony and Matsushita will have to work very hard to succeed on the second try. If these two companies come in with machines that are not only compact and convenient but also are as powerful as the IBM Personal Computer, look out!

Any of the companies described in this article, as well as their American competitors, could get a lead on the others by bringing to market a system with clearly superior performance for the price. One obvious strategy would be to sell a standard built-in micro-Winchester hard disk for about the price of two standard floppy-disk drives. Veteran microcomputer users know how much faster the hard disks make many operations, and novices could tell at a glance when shopping for a system. Japanese and American computer companies with experience in manufacturing hard disks could turn that experience to advantage by mass producing micro-Winchesters and selling them at mass-market prices.

Here's where speculation ends and a pipe dream begins (no reference to Unix intended). Imagine an 8086-based system with 256K-bytes of RAM, a CP/M-86 or MS-DOS operating system, BASIC in ROM, and a keyboard of high quality and versatility. That sounds a lot like a fully equipped IBM Personal Computer. Add a built-in micro-Winchester drive, a fold-away flat-screen video display, a built-in LSI 1200-bit-per-second modem, a home-appliance controller, and sell the whole thing for $3500 or less. Offer a high-quality RGB color monitor for $500. Then IBM, Radio Shack, and Apple would have something to worry about. ■

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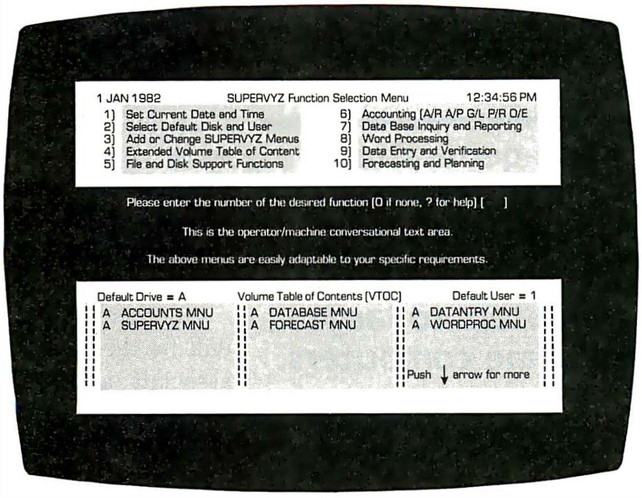
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Japan Maps Computer Domination

Ten-year research and development effort leading to fifth-generation systems for the 1990s is aimed at leapfrogging U.S. technology.

Tom Manuel
Computers & Peripherals Editor
ELECTRONICS

The Japanese have set out to leapfrog U.S. computer technology and become the world's leading suppliers of advanced computer systems. After two years of study and research, the Japanese Information Processing Development Center—JIPDEC—has hammered out a body of ideas, plans, and recommendations for projects that will culminate in what it calls a fifth-generation system by 1990.

The plan for research and development during the coming decade neatly integrates many of the innovative ideas from researchers in the U.S., Japan, and the rest of the world, extending and fitting them into the new system [ELECTRONICS, November 3, 1981, p. 71].

What makes the goal entirely believable is the Japanese ability to turn such efforts into a national project. That gives them, in effect, a national computer policy that is concentrated, organized, and possibly government-backed in a way that other countries cannot match.

Fifth-generation computers will come in sizes ranging from small personal computers to large mainframe computers.

Problem Solver

To meet Japan's needs, the computer of the future, in addition to having a higher performance level at lower cost, must be able to handle many more general problem-solving tasks than today's machines. In addition, the system must be as natural for people to use as it is for them to speak. Access is to be through natural language, everyday speech, and pictures. The system that will perform this feat is being called the intelligent-interface machine (see figure 1).

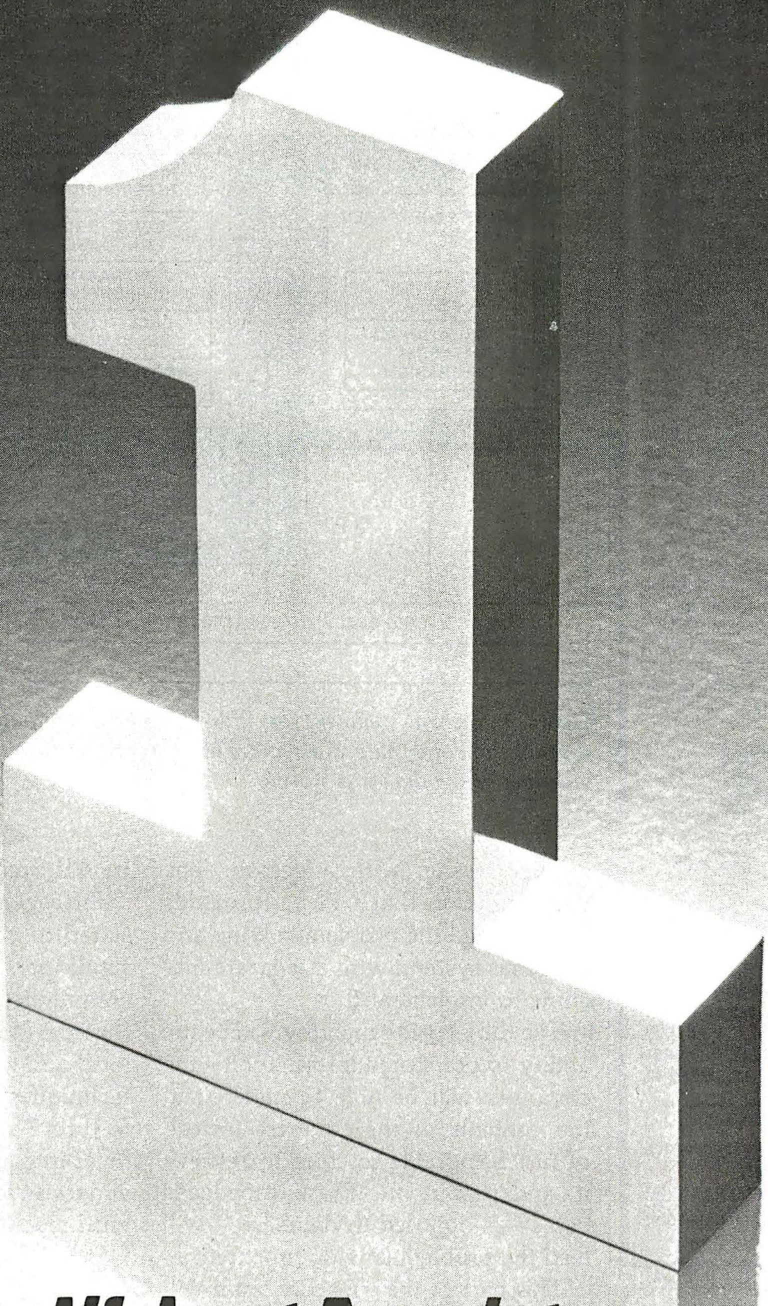
Another of its three basic functions will be the system's ability to learn, associate, and infer, just as people do. The computer will be able to clarify even vague requests and then, by using its vast store of information or that available from other computers, make judgments that will enhance the thinking capacity of its human masters.

In other words, the computer could carry on an intelligent question-and-

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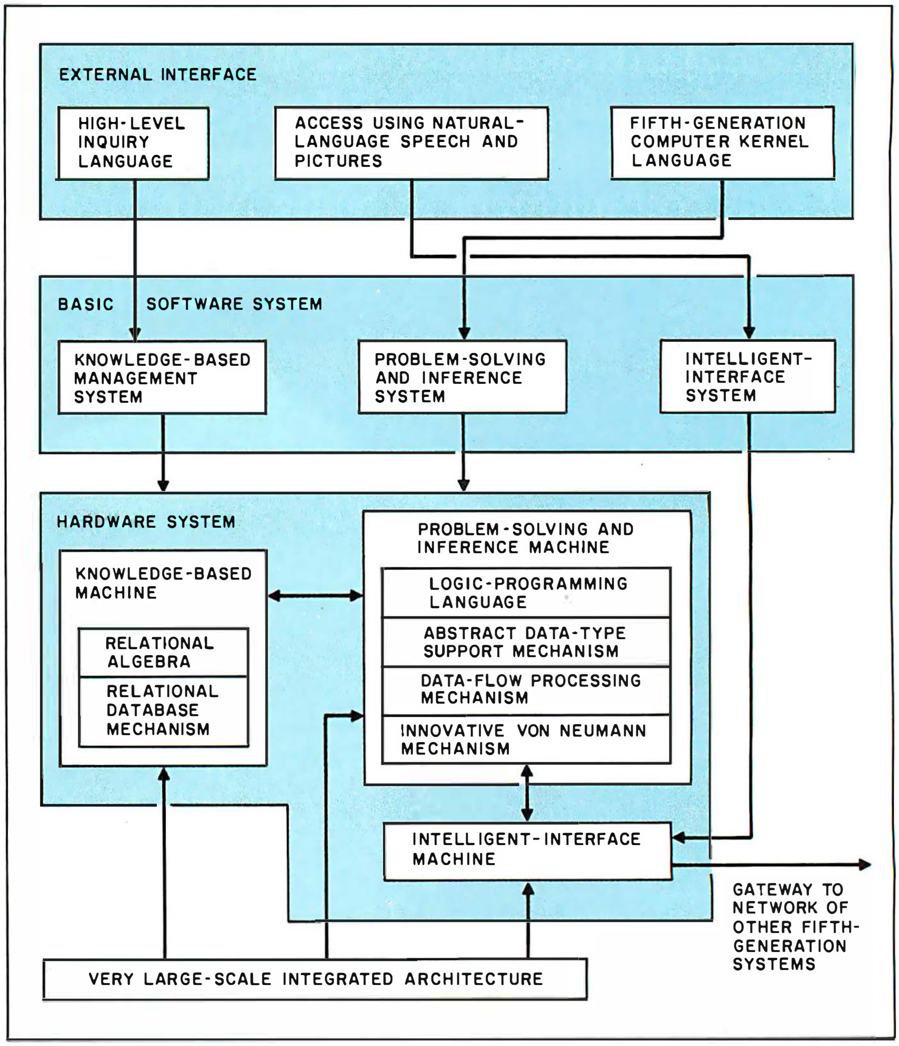


Figure 1: *System planned for fifth-generation computers. The intelligent-interface machine will offer natural-language access, the ability to learn and infer, and an understanding of the data it is storing.*

answer session with a person. The basic function that will perform this feat is called the problem-solving and inference system, with a separate machine to implement it.

The third basic capability will be the ability to use stored information—the computer will be able to understand the contents of the database instead of just being able to store it, retrieve it, and pass it on. These knowledge bases—as opposed to databases—will feed the problem-solving function.

This part of the tripartite brain will be called the knowledge-based management system. It, like the other two, will have its own specialized machine to use advanced very large-scale integration (VLSI).

In All Sizes

Fifth-generation computers are slated to come in sizes ranging from small personal to large mainframe computers. It should be no surprise that they will be interconnected with local and global networks. Some new techniques to be used are new architectures like data-flow machines, artificial-intelligence concepts, and languages such as Lisp and Prolog along with machines optimized for them.

JIPDEC has recommended 26 research and development themes, each with several projects. The themes are grouped into seven categories (see table 1). Each theme has target specifications.

For example, a personal work sta-

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EASE OF USE			
Programmable Soft Keys	10	0	14
Error Messages	73	38	107
Built-in Disc Operating System	No	No	Yes
Built-in Screen Graphics	No	Yes	Yes
RELIABILITY			
Self Diagnostics	Yes	No	Yes
Operating Temperature	61-90°F	No figures available	32-133°F

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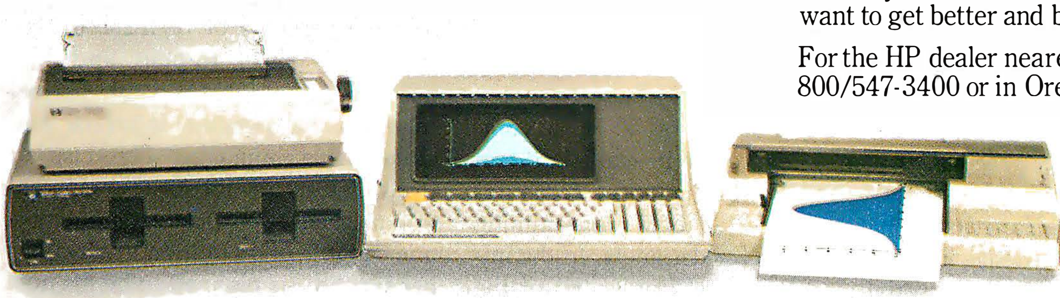
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Basic-Application Systems	Distributed-Function Architecture	Systematization Technology
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Development Supporting Technology • Development-support system **Very Large-Scale Integrated Technology** • VLSI architecture • Intelligent VLSI computer-aided design system	**New Advanced Architecture** • Logic-programming machine • Functional machine • Relational-algebra machine • Abstract data-type support machine • Data-flow machine • Innovative von Neumann machine	**Basic-Software Systems** • Knowledge-based management system • Problem-solving and inference system • Intelligent-interface system

Table 1: *Scope of the fifth-generation project.*

tion would be required to perform 2 million instructions per second, have from 0.5 to 5 megabytes of memory, and include 100 megabytes of disk storage with an average access of 1 millisecond. Other specifications include what is referred to as a super high-speed processor to perform from 1 billion to 100 billion floating-point operations per second and have a memory capacity of 8 to 160 megabytes.

Big Numbers

Designers hope to create a problem-solving and inference function that will have a performance of 100 million to 1 billion logical-inference operations per second (one logical inference equals 100 to 1000 instructions). Another project example is the specifications for a natural-language processing system. In addition, the knowledge-based management function should retrieve a unit of knowledge in several seconds from a knowledge base of 100 to 1000 gigabytes.

Very large-scale integration technologies, first with 1 million transistors per chip and then up to more than 10 million, are to be used. A design-automation system for these integrated circuits will also be developed.

Newer high-speed device technologies such as gallium arsenide and Josephson junctions are excluded from the program because the researchers believe that such devices will not be ready for general use by 1990. However, they do maintain that the progress of these devices will be closely watched so that they can be incorporated into the project at some intermediate stage should they prove sufficiently practical and capable of superior performance.

The design-automation system is to consist of three parts: the software for automated design of VLSI, a computer system to run it—called System 5G—and the 5G personal computer that will be a logic-programming work station for designers. In the initial stage (the first five years) of the project, the planners intend to implement the Hierarchical Specification Language (HSL) now being used at the Musashino Electrical Communication Laboratory of the Nippon Telegraph & Telephone Public Corp.

The HSL system has several modules that are integrated into a total design system. It contains a language for describing a circuit, compiler, database, timing simulator, logic simulator, circuit simulator, test-pattern generator, placement and routing program, and design-rule checker.

Logic Designer

Also part of the design-automation project is the development of the logic-programming work station. No existing personal computer satisfies the requirements of high-speed processing of voice, graphic, and digitized-image input and of performance as a personal-interface machine using languages like Lisp or Prolog. One of the fastest conventional general-purpose computers—one capable of 40 million instructions per second—is planned to be the host computer for the design-automation system until the first models of fifth-generation computers are available. ■

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The Atari Tutorial

Part 9: Even More Colors!

Television artifacts and the new GTIA chip allow even more colors to be displayed on Atari computers.

Kathleen Pitta and Lane Winner
Atari Inc.
30 East Plumeria
POB 50047
San Jose, CA 95134

The Atari 400 and 800 home computers allow the programmer to display many colors with their powerful color-register systems. Even more colors can be obtained with television artifacts and the new GTIA chip.

Television Artifacts

A *television artifact* is a pixel on the screen that displays a different color on the screen than the one assigned to it. This happens because the television display signal can become confused. The astute programmer can turn this bug into a feature. The ANTIC modes with which this can be accomplished are 2, 3, and 15. [*Remember that the ANTIC mode numbers are not the same as the BASIC "GRAPHICS* n*" numbers; ANTIC mode 15 is* not *a mistake.* . . . **G. W.**] Each of these modes has a pixel resolution of one-half color clock by one scan line; each has one color and two luminances. With the use of artifacts, pixels of four different colors can be displayed on the screen in each of these modes.

A simple example of artifacts when using the Atari home computer is shown by the following lines of BASIC:

```
GRAPHICS 8
COLOR 1
POKE 710,0
PLOT 60,60
PLOT 63,60
```

These statements plot two points on a black background, each with a different color. To understand why these colors are different, you must first understand how the display information for the television display is contained in a modulated television signal.

The two major components of this signal are the *luminance* (or brightness) and the *color* (or tint). The luminance information is the primary signal, containing not only the brightness data but also the timing and synchronization signals. The color signal contains the color information and is combined or modulated onto the luminance waveform.

The luminance of a pixel on the screen is directly dependent on the amplitude of the luminance signal at that point. The higher the amplitude of the signal, the brighter the pixel. The color information, however, is a *phase-shifted signal,* which is a constantly oscillating waveform that has been delayed by some amount of time relative to a reference signal. This time delay is translated into the color.

The color signal oscillates at a constant rate of about 3.579 megahertz (MHz). The Atari home computer offers a high-resolution graphics mode (GRAPHICS 8) that displays 320 pixels across one horizontal scan line. The hardware does this by varying the amplitude of the luminance signal at 7.16 MHz, which is twice the color frequency. Since the color and lumi-

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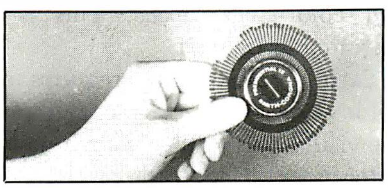
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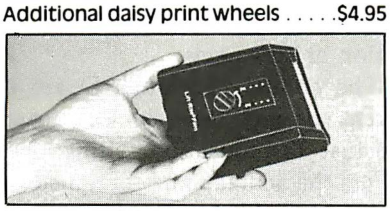
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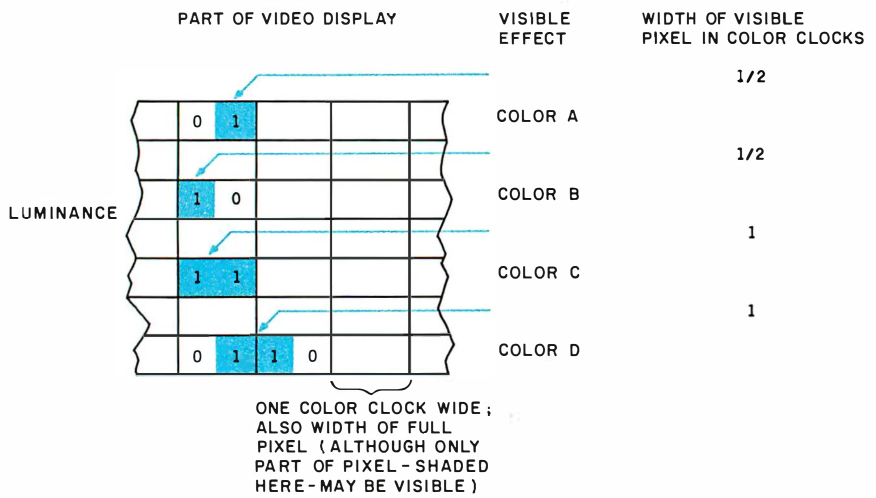


Figure 1: *In this example of artifact color pixels, the visible portion of a pixel is one-half color clock wide, and its position within a color clock influences the color produced. See figure 2 and listing 1 for another example of artifact color pixels.*

nance signals are theoretically independent, you should be able to assign any background color to be displayed and then vary the luminance on a pixel-by-pixel basis. This is, in fact, the way mode 8 works, the background color coming from playfield register 2 and the luminances coming from both playfield registers 1 and 2.

However, a problem does arise. In practice, the color and luminance signals are not independent. They are part of a modulated signal that must be demodulated by the television receiver before they can be used. Since the luminance is the primary signal, whenever it changes, it also has a drastic effect on the color phase shift. For one or more color clocks of constant luminance this is no problem, since the color phase shift will be unchanged in this area. However, if the luminance changes on a half color-clock boundary, it will also produce a color shift at that point. Moreover, the color obtained cannot be controlled from the transmitting end of the signal (the computer). The artifact color obtained is defined by the settings of the television receiver.

(A color clock is a *physical* unit of horizontal distance on the video display—160 color clocks per line of video display. A pixel is a *logical* unit of video display with a size that varies with the graphics mode in use. Depending on the graphics mode, a pixel may be one-half, one, two, or more color clocks wide.)

Since the luminance can change on half color-clock boundaries, two artifact colors can be generated, one for each side of the color clock. These two artifact color pixels can be combined to form two additional types of full color-clock pixels. This is illustrated in figure 1.

The artifact colors are definitely distinct from each other, and programs can be written that utilize them.

Each of these pixels requires one color clock of screen space (although the visible part of the pixel is one-half color clock). Hence, the resulting display has an effective horizontal resolution of 160 pixels.

The colors A through D are different for each television set, usually because the tint-knob settings vary. Thus, the actual colors obtained cannot be controlled by the programmer. They are definitely distinct from each other, and programs can be written that utilize these artifact colors.

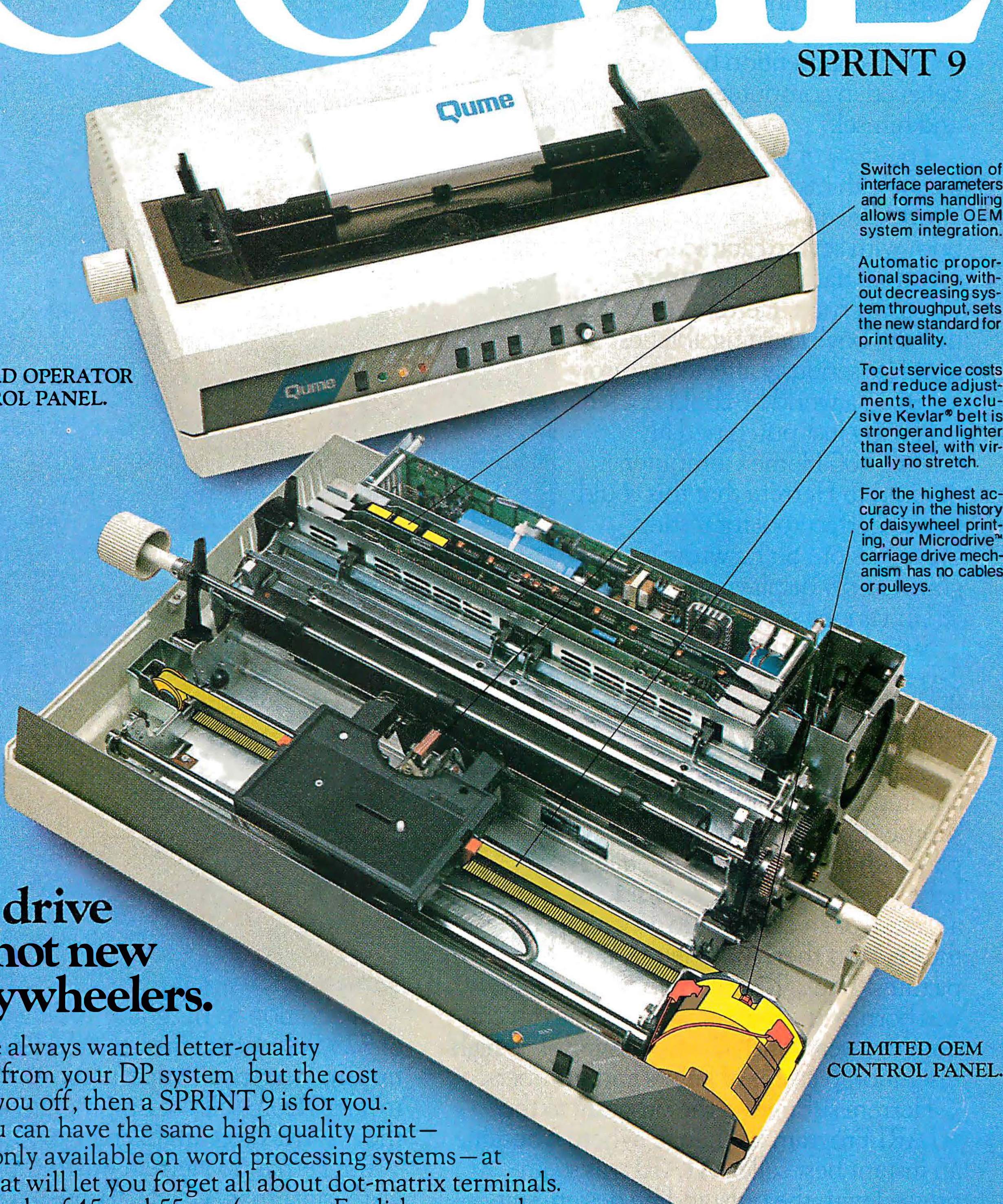
To illustrate a simple application of artifacting, refer to the sample program in listing 1. This program draws lines in each of the four artifact colors (see figure 2) and then fills in areas using three of the colors. (Displaying many pixels of either type C or D next to each other results in the same thing: a line of constant luminance with background color.) The POKE 87,7 command causes the operating system to treat this mode as mode 7 instead of mode 8 and to use 2-bit masks when setting bits in the display memory; this tricks the Atari into creating pixels one-half color clock wide. To generate color A, use the COLOR 1 command. The COLOR 2 command produces color B; the COLOR 3 command produces color C. Color D is generated by displaying COLOR 1 to the left of COLOR 2.

The GTIA Chip

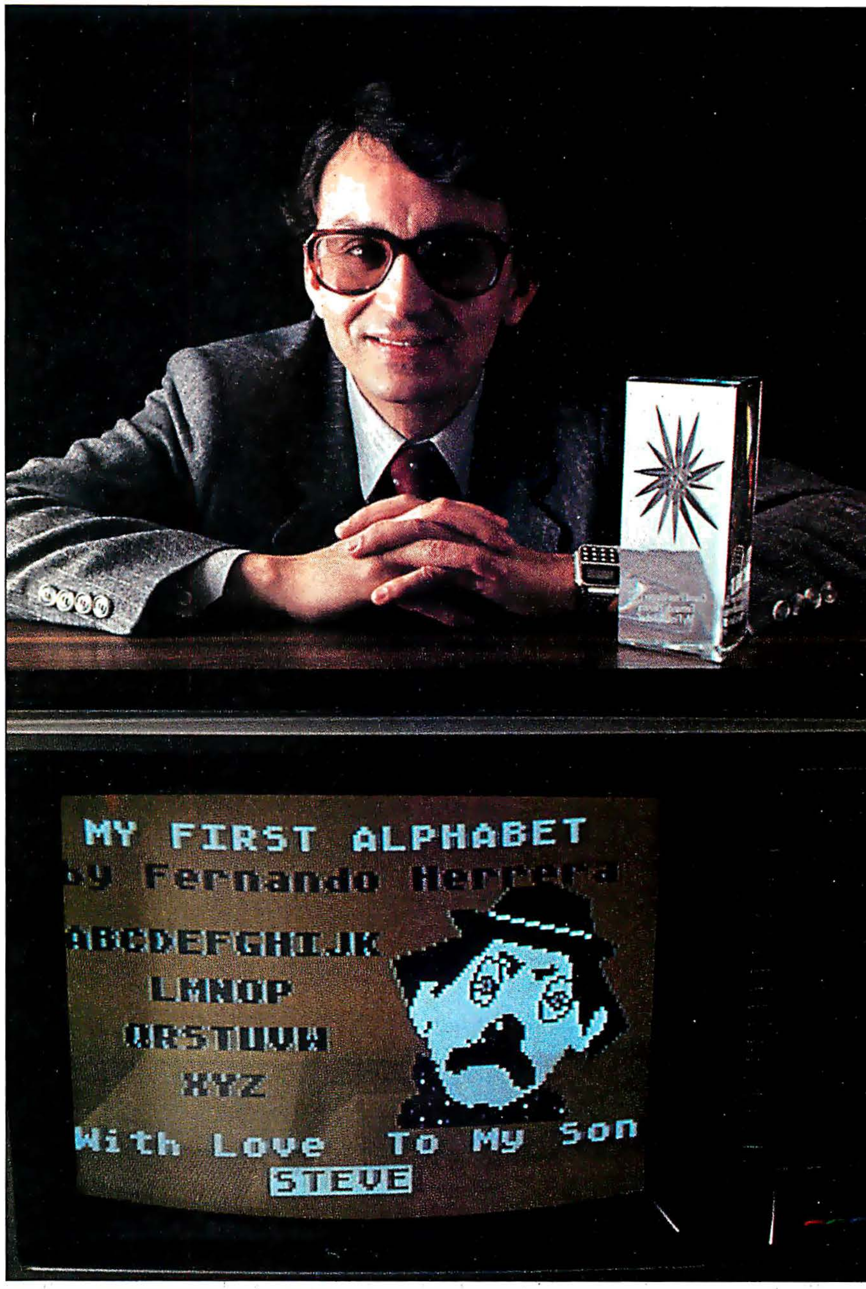
The new GTIA display chip for the Atari home computer will someday replace the CTIA chip currently in use. The GTIA is nothing more than a CTIA with a few extra features. It provides three additional modes of interpretation of information coming from the ANTIC chip. ANTIC does not require a new display mode to use the special GTIA modes; instead, it uses the high-resolution mode F hexadecimal. GTIA is completely upward-compatible with the CTIA. A brief summary of the CTIA's features follows so that the differences between the two can be explained.

The CTIA is designed to display data on a television screen. It displays the playfield, players, and missiles. CTIA uses the data from ANTIC to display hue and luminance as defined by the four color registers. The GTIA expands this to use all nine color registers or 16 hues with one luminance or 16 luminances of one hue.

The three graphics modes of GTIA are simply three new interpretations of ANTIC mode F hexadecimal, a high-resolution mode. All three modes affect the playfield only. Players and missiles can still be added to introduce new hues or luminances, or to use the same colors and luminances in more than one way. All displays of hues and luminances can still be changed on-the-fly with


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Herrera submitted the program to the ATARI Program Exchange, where it became an instant best-seller. ATARI was so impressed with the outstanding design, suitability and graphic appeal of "My First Alphabet," that the program is being incorporated into the ATARI line of software.

In addition to his grand prize winnings of $25,000 in cash and an ATARI STAR trophy, Herrera also automatically receives royalties from sales of his program through the ATARI Program Exchange.

But Fernando Herrera wasn't the only software "star" that ATARI discovered. Three other ATARI STARS were awarded at the ASAP awards ceremony for software submitted to the ATARI Program Exchange and

judged by ATARI to be particularly unique and outstanding.

Ron and Lynn Marcuse of Freehold, New Jersey, teamed up to write three winning entries in the Business and Professional category for home computers: "Data Management System," "The Diskette Librarian" and "The Weekly Planner."

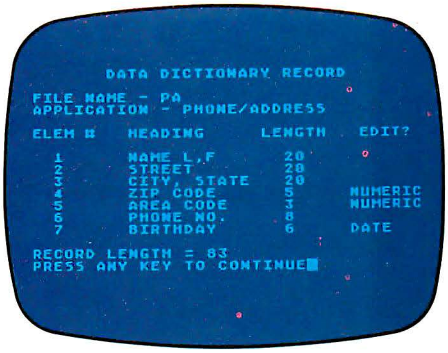
Sheldon Leeman of Oak Park, Michigan, captured an ATARI STAR for his exceptionally well-engineered "INSTEDIT" character set editor.

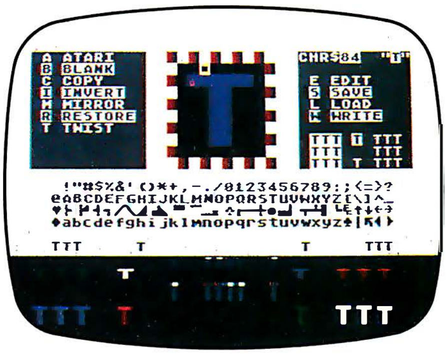
Greg Christensen of Anaheim, California, became our youngest ATARI STAR winner at the age of 17. Christensen designed the clever "Caverns of Mars" game program, which also will be incorporated into the ATARI product line. Greg designed the program in 1½ months after owning his ATARI Home Computer for less than a year.

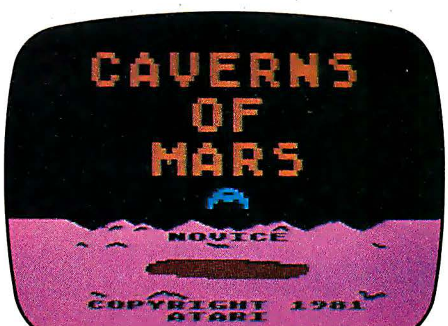
Every three months, ATARI awards ATARI STARS to the writers of software programs submitted to the ATARI Software Acquisition Program and judged first, second and third place in the following categories: Consumer (including entertainment, personal interest and development); Education; Business and Professional programs for the home (personal finance and record keeping); and System Software.

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Listing 1: *An Atari BASIC program to display artifact colors. See the text and figures 1 and 2 for details.*

```
10 GRAPHICS 8:POKE 87,7:POKE 710,0:POKE 709,14
20 COLOR 1:PLOT 10,5:DRAWTO 10,70
30 PLOT 40,5:DRAWTO 40,70
40 COLOR 2:PLOT 20,5:DRAWTO 20,70
50 PLOT 41,5:DRAWTO 41,70
60 COLOR 3:PLOT 30,5:DRAWTO 30,70
70 FOR X=1 TO 3:COLOR X:POKE 765,X
80 PLOT X*25+60,5:DRAWTO X*25+60,70
90 DRAWTO X*25+40,70:POSITION X*25+40,5
100 XIO 18,#6,12,0,"S:"
110 NEXT X
```

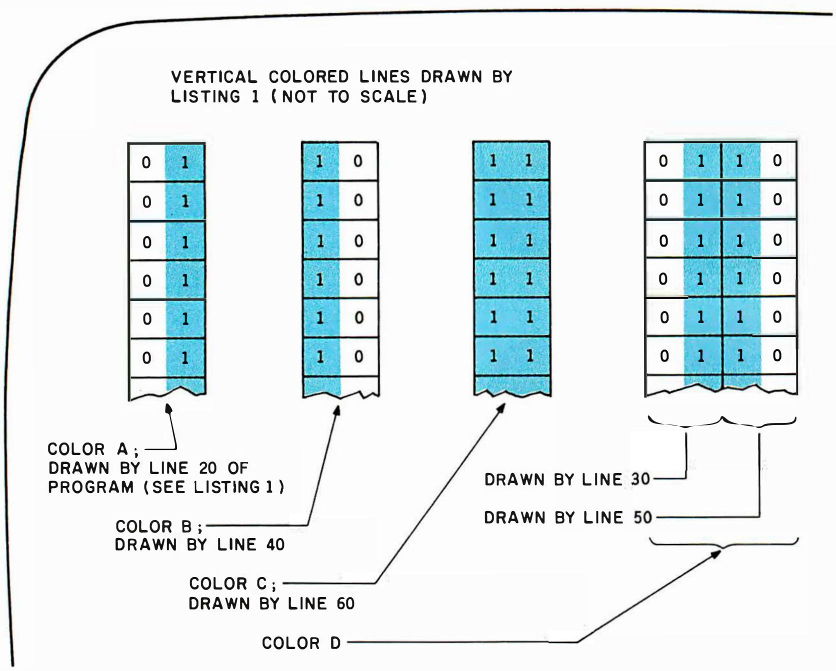


Figure 2: *An enlarged view (not to scale) of the upper left-hand corner of the video display produced by listing 1. This figure helps to explain how listing 2 produces four colored vertical lines from three different types of pixels.*

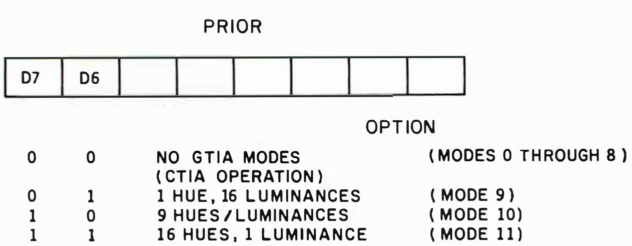


Figure 3: *Activation of graphics modes 9, 10, and 11. The two most significant bits of the hardware register PRIOR control the selection of these modes. For information on the use of the low 6 bits of the PRIOR register, see page 338 of the November 1981 BYTE.*

display-list interrupts. The GTIA uses 4 bits of data from ANTIC for each pixel, called the pixel data. Each pixel is two color clocks wide and one scan line high. Thus, the pixels are roughly four times wider than their height. The display has a resolution of 80 horizontal pixels by 192 vertical pixels. Each line requires 320 bits (40 bytes) of memory, the same number used in ANTIC mode F hexadecimal. Therefore, for a program to run the GTIA modes, it must have at least 8K bytes of free RAM (random-access read/write memory) for the display.

The GTIA modes are selected by the priority register PRIOR, which is located at address D01B hexadecimal and shadowed at address 26F hexadecimal. [*The contents of shadow registers are copied into their associated registers every 1/60 second. Thus, you will usually alter shadow registers, not the hardware registers themselves. . . .* G. W.] Bits D6 and D7 are the controlling bits. The effects of these bits are presented in figure 3.

Setting up the new GTIA modes is as simple as setting up the present modes supported by CTIA. To implement the modes from BASIC, simply use a GRAPHICS 9, GRAPHICS 10, or GRAPHICS 11 command. In assembly-language programs, selecting one of these modes is done by opening the screen device through CIO. If you are building your own display list, PRIOR must be set to select the correct mode.

Mode 9

Mode 9 produces up to 16 different luminances of the same hue. ANTIC provides the pixel data that selects one of 16 different luminances. The background color register provides the hue. In BASIC, this is done by using the SETCOLOR command to set the hue value in the upper nybble (4 bits) of the background color register and to set the luminance value in the lower nybble to all zeros. The format of the command is

SETCOLOR 4,HUEVALUE,0

where 4 specifies the background

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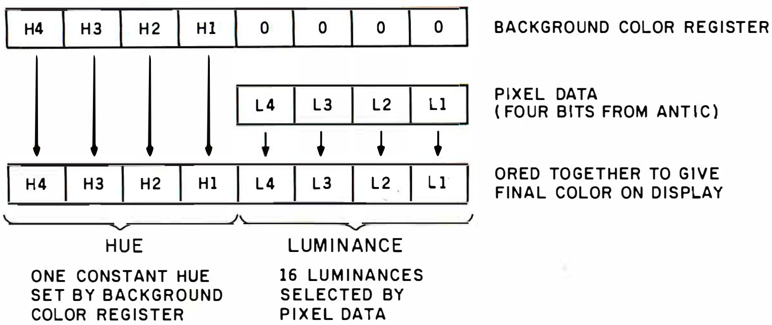


Figure 4: *Interpretation of a byte of memory as a color pixel in graphics mode 9. Mode 9 gives one hue at 16 possible luminances.*

Listing 2: *An Atari BASIC program that illustrates BASIC graphics mode 9 by drawing 16 vertical lines of varying luminances (same hue).*

```
10 GRAPHICS 9
20 SETCOLOR 4,12,0:REM initialize the background color to green
30 FOR I=0 TO 15:REM draw in different luminances
40 COLOR I
50 PLOT 2*I,10
60 DRAWTO 2*I,80
70 NEXT I
80 GOTO 80:REM hang up in a loop
```

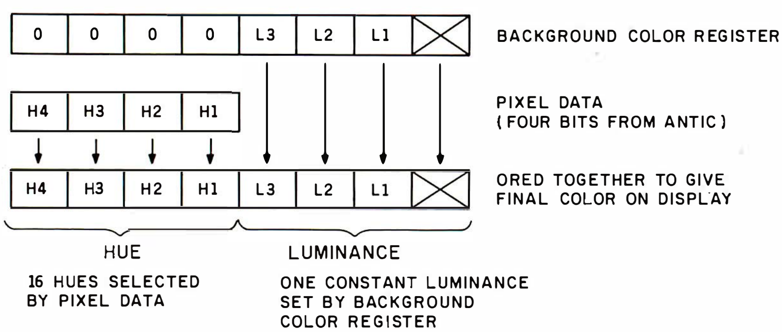


Figure 5: *Interpretation of a byte of memory as a color pixel in graphics mode 11. Mode 11 gives up to 9 hues at the same luminance level.*

Listing 3: *An Atari BASIC program that illustrates BASIC graphics mode 11 by drawing 16 vertical lines of varying hues (same luminance).*

```
10 GRAPHICS 11
20 SETCOLOR 4,0,12:REM initialize the background color
30 FOR I=0 TO 15
40 COLOR I:REM select different colors
50 PLOT 2*I,10
60 DRAWTO 2*I,80:REM draw bars in different colors
70 NEXT I
80 GOTO 80
```

color register, HUEVALUE sets the hue and can be anything from 0 to 15, and 0 sets the luminance part of the register to zero. The background luminance *must* be zero because the pixel data from ANTIC will be logically ORed with the lower nybble of the background color register to get the luminance that appears on the screen (see figure 4). Use the COLOR command to select luminances for drawing on the screen; its argument (ranging from 0 to 15) specifies the luminance. A sample BASIC program to use mode 9 is shown in listing 2.

Assembly-language programs should write the hue directly into the upper 4 bits of the shadow location for the background color register at location 2C8 hexadecimal. If you use CIO calls to draw to the screen, store the pixel data into ATACHR located at 2FB hexadecimal. This selects the luminance with values from 0 to F hexadecimal. If you are maintaining your own display data, the pixel data goes directly into the left or right half of the display RAM byte.

Mode 11

Mode 11 is similar to mode 9 except that it provides 16 different hues all with the same luminance. ANTIC provides the pixel data to select one of 16 different hues (see figure 5). In BASIC, use the SETCOLOR command to declare the single luminance value in the lower nybble of the background color register. Set the upper nybble of the background color register (the hue nybble) to zero. The format of the command is

SETCOLOR 4,0,LUMVALUE

where 4 specifies the background color register, 0 sets the upper nybble to zero, and LUMVALUE sets the value of the luminance and can range from 0 to 15. As with the other graphics modes (except mode 9), the lowest bit of the luminance is not used. The effective result is that only even numbers result in distinct luminances, which gives eight possible luminances in this mode. Use the COLOR command in this mode to select the various hues by selecting values from

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0	D012	2C0
1	D013	2C1
2	D014	2C2
3	D015	2C3
4	D016	2C4
5	D017	2C5
6	D018	2C6
7	D019	2C7
8	D01A	2C8

Table 1: *Addresses of color registers and their shadow locations affected by the COLOR statement in BASIC.*

Listing 4: *An Atari BASIC program that illustrates BASIC graphics mode 10 by drawing 16 vertical lines of varying hues and luminances.*

```
10 GRAPHICS 10
20 FOR I=0 TO 8
30 POKE 704+I,255*RND(I):REM set random colors
40 COLOR I
50 PLOT 2*I,10
60 DRAWTO 2*I,80:REM draw in bars of color
70 NEXT I
80 GOTO 80:REM hang up in a loop
```

0 to 15 for its argument. The pixel data from ANTIC will be logically ORed with the upper nybble of the background color register to set the hue part of the value that ultimately generates the color on the screen. A sample BASIC program using mode 11 is presented in listing 3.

In assembly language, use the operating-system shadow location for the background color register (at 2C8 hexadecimal) to set the luminance in the lower 4 bits with values from 0 to F hexadecimal. If you use CIO calls to write to the screen, store the pixel data to be written into ATACHR located at 2FB hexadecimal. This selects the hue with values from 0 to F hexadecimal. If you are maintaining your own display data, the pixel data goes directly into the left or right half of the display RAM byte.

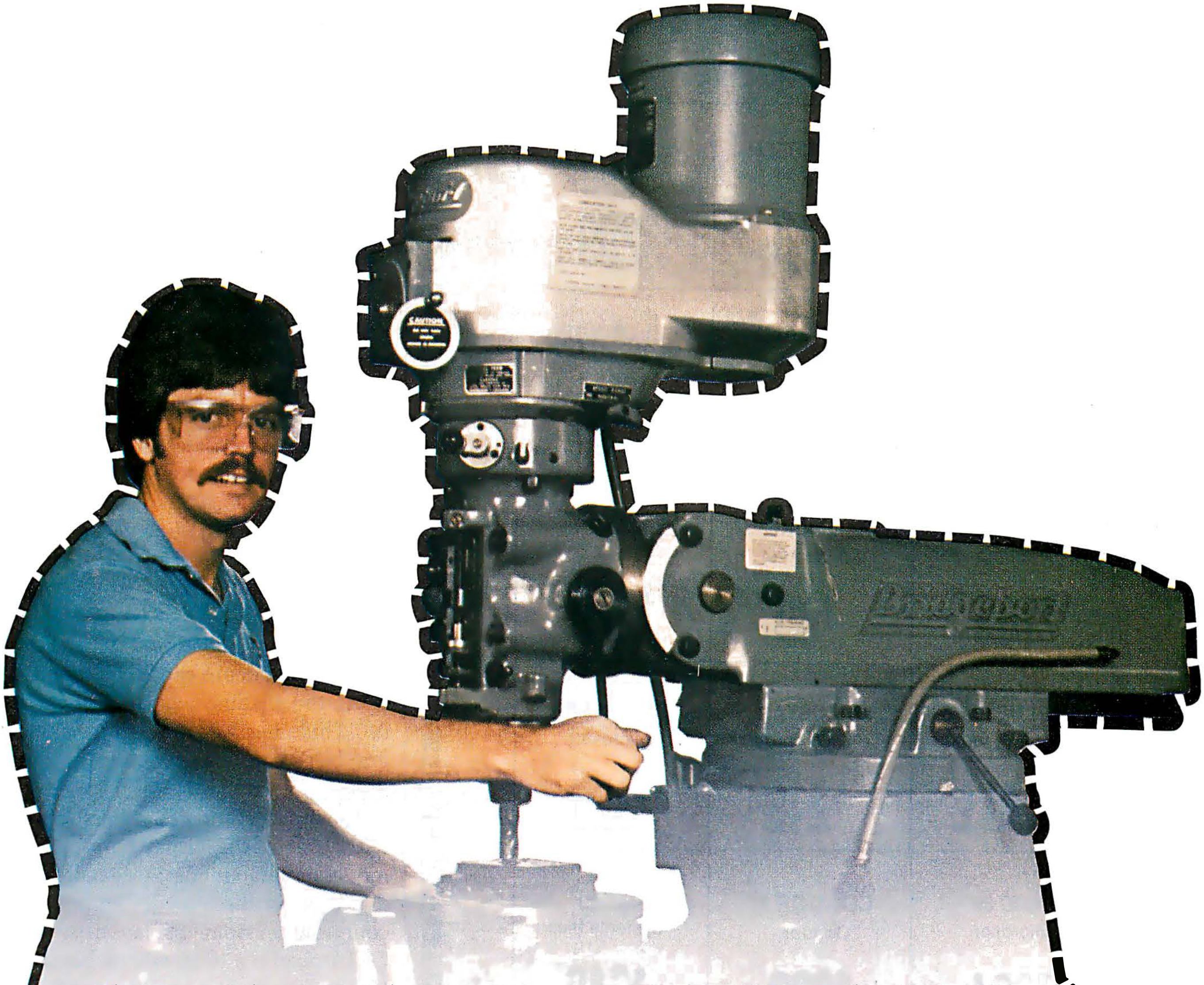
Mode 10

Mode 10 allows all nine color registers to be used in the playfield at one time. Each color register to be used must be set to some combination of hue and luminance. The pixel data from ANTIC is used in this mode to select one of the color registers for display. In BASIC, the SETCOLOR command can be used as described in the *Atari 400/800 BASIC Reference Manual* to set the colors in the background and the four playfield registers. These can also be set by using the POKE instruction to addresses 708 through 712 decimal where the four playfield registers and the background register are located. The POKE instruction must be used to set the four player/missile color registers at locations 704 through 707 decimal. The COLOR command is used to select the color register desired, as shown in table 1. The only meaningful values for its argument are 0 to 8.

A problem arises with this mode. ANTIC supplies 4 bits of data per pixel, as it does with modes 9 and 11. This allows for the selection of 16 color registers. However, only nine color registers exist in the hardware. An illegal data value between 9 and 15 will select one of the lower-value color registers. A sample BASIC program using mode 10 is given in listing 4.

In assembly language, store the pixel data into ATACHR (location 2FB hexadecimal) or directly into the

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display RAM byte, as in modes 9 and 11. In this mode, the pixel data can range from 0 to 8 and selects one of the nine color registers.

Advantages and Disadvantages

An important question arises in conjunction with GTIA concerning compatibility. GTIA is fully upward-compatible with the CTIA, and all software that runs on a CTIA system will run the same way on a system with GTIA. This means you still have full use of players and missiles, collision detection, and display-list interrupts. The GTIA graphics modes are supported by the operating system, and all graphics commands and utilities that run in the CTIA modes can be used in GTIA modes.

The GTIA allows the programmer to display more colors on the screen with less work. Sixteen colors can be shown on one horizontal line. This is better than what can be done with horizontal kernels (see "The Atari Tutorial, Part 4: Display-List Interrupts," December 1981 BYTE, page 181) that can give a maximum of 12 colors per horizontal line. Much finer contour and depth can be represented using the shading available in mode 9. This means three-dimensional graphics can be realistically displayed.

Some disadvantages are associated with use of the GTIA chip. GTIA modes are map modes; text cannot be displayed in these modes without recourse to custom display lists. The GTIA pixel is a long, skinny horizontal rectangle (4:1 ratio, width to height) that does not represent curved lines well. Because each pixel uses 4 bits of information, GTIA requires nearly 8K bytes of free RAM to operate. Although it is upward-compatible, it is *not* downward-compatible. Thus, programs that use GTIA modes will *not* produce correct displays on computers that have CTIAs. There is no way currently for a program to determine whether or not a GTIA is present in a system. Finally, color artifacts produced by a GTIA system will not be identical to the color artifacts produced on the same television with a CTIA system. ■

AH-HA!





EUREKA!

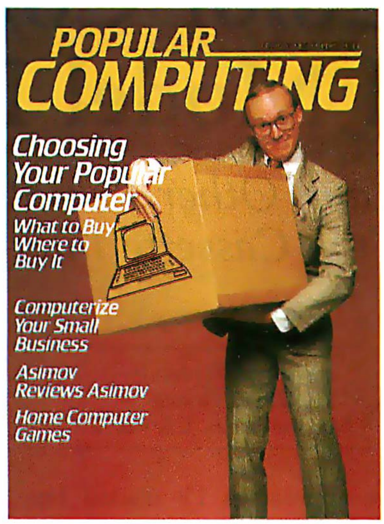
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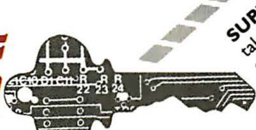
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In the last article of this series, I discussed using the cassette output of the Model I and Model III as a single discrete output line to drive a music synthesizer, telephone dialer, and serial port. This month I'll look at the inverse—implementing discrete (binary) inputs on the Color Computer and Model III. (Unfortunately, the schemes I'll be using are not applicable on the Model I, so it will be slighted somewhat in this article.)

Of course, it's possible to implement *dozens* of discrete input lines to the Model I, Model III, or Color Computer by using a peripheral interface adapter (PIA) or peripheral input/output (PIO) device such as the 8255 semiconductor chip. This method requires four or five integrated circuits in addition to the PIO or PIA.

The approaches I'll discuss here, however, involve using few additional components other than sensors. This cheap and dirty approach can be used to detect remote switch closures (e.g., in burglar alarms and fire detectors); it can even be used to receive serial data (e.g., pulses generated by a telephone-type rotary dial).

The anemometer is constructed with plastic sprinkler fittings, wooden dowels, and plastic cups. Do some preliminary testing before using it atop a 200-foot tower.

Discrete line inputs can also serve as a frequency counter. With the proper sensors and software, you can implement a low-frequency counter that easily measures thousands of counts per second; the software can handle switch bounce too.

As an example of a practical application of this discrete line input, I'll show you how to construct an anemometer that will measure wind speeds from 2½ to over 60 miles per hour. Believe it or not, this device costs less than $10 and can be made by hackers without opposing thumbs.

Where Are the Discrete Inputs?

Looking at the Color Computer, you can spot several potential discrete inputs: two joystick jacks, a cassette jack, and an RS-232C jack.

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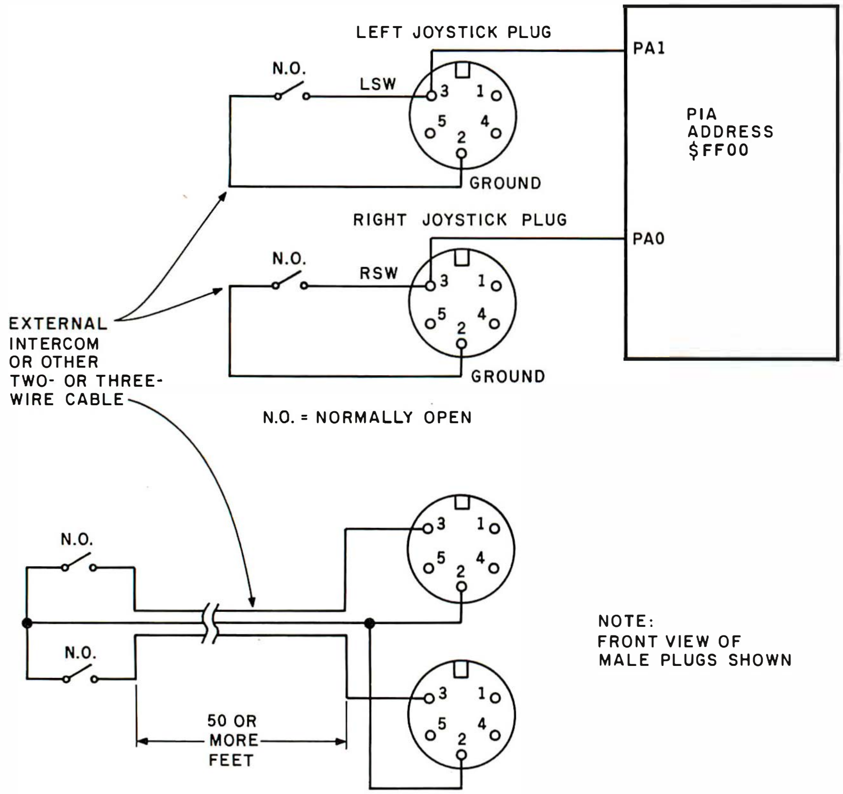


Figure 1: *The Color Computer joystick switch inputs can be connected to external single-pole, single-throw (SPST) or single-pole, double-throw (SPDT) switches for remote sensing applications. Cable runs can be up to 50 feet.*

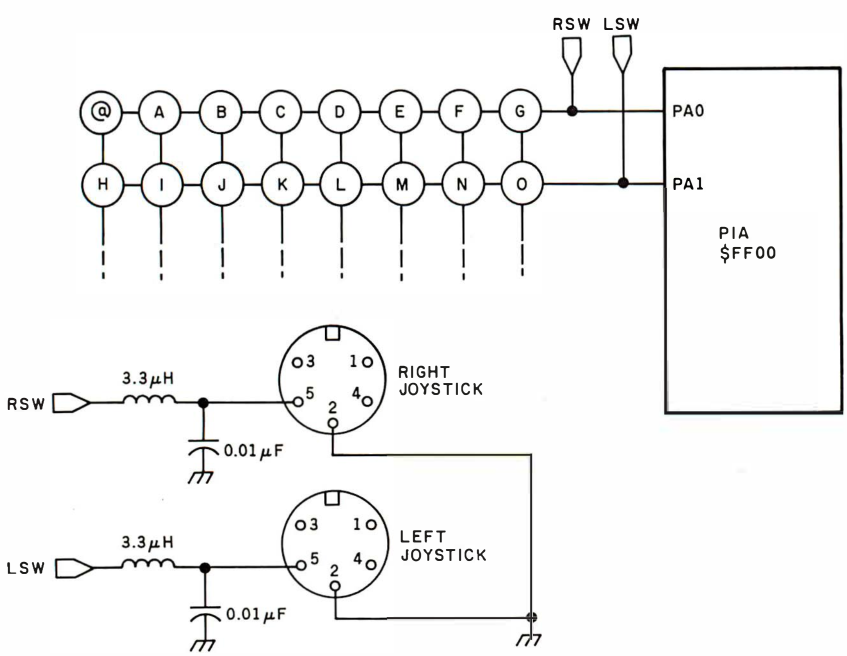


Figure 2: *The Color Computer joystick switch inputs are "wire ORed" to two keyboard rows. Since the keyboard is never used at the same time as the switches, this causes no sensing problems.*

Joystick switch inputs. The left and right joysticks have four analog channels that could be used as discrete inputs. Even more promising, however, are the joystick "switch" inputs.

The joystick switches (shown in figure 1) are normally open switches that close to ground. The output of each switch goes to bit 0 (right joystick) and bit 1 (left joystick) of PIA address hexadecimal FF00. As you can see from figure 2, the switch inputs to the PIA are shared by two keyboard rows; normally, you wouldn't be using the keyboard and joystick switches at the same time. The joystick switches connect to the PIA through a small filter made up of a choke and bypass capacitor as shown in the figure; this eliminates some input noise.

Substituting an external switch (or switches) for the joystick switches, a cable can be run 50 feet or more to a remote location. This procedure is not generally recommended with an unterminated input, but I experienced no difficulties and no false readings in a home environment with a 60-foot intercom cable.

The program used is shown in listing 1, which simply checks for a 1 or 0 on either joystick input. This Extended Color BASIC program loops at about 30 senses per second, making the scheme fine for switch closures in burglar alarms, fire detectors, microswitches in mailboxes triggered by the weight of the mail, and so forth. At this point it's probably well to mention a typical switch that can be used for remote sensing. Radio Shack has submini lever switches with and without rollers (275-017 and 275-016, respectively), which require about 50 grams of force to operate. These switches were used in the applications described here, although virtually any single-pole, double-throw (SPDT) switch could be used.

RS-232C input. Another possibility for a discrete input on the Color Computer is the RS-232C read (RD) input. This line is normally used to input serial data and, as figure 3 shows, it connects to an LM339 comparator in the Color Computer. One input to the comparator is a voltage divider made up of a 15-kilohm (kΩ)

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Listing 1: *Sample Color Computer BASIC program for reading joystick switch closures.*

```
100 ' SWITCH CLOSURE FOR RIGHT AND LEFT JOYSTICK
110 INPUT "RIGHT(R) OR LEFT(L) DETECT";A$
120 IF A$="R" THEN M=1 ELSE M=2
130 A=(PEEK(&HFF00) AND M)
140 IF A=M THEN PRINT "OFF" ELSE PRINT "ON"
150 GOTO 130
```

Listing 2: *Sample Color Computer BASIC program for reading RS-232C RD inputs.*

```
100 ' SWITCH CLOSURE FOR RS-232-C RD INPUT
110 A=(PEEK(&HFF22) AND 1)
120 IF A=0 THEN PRINT "ON" ELSE PRINT "OFF"
130 GOTO 110
```

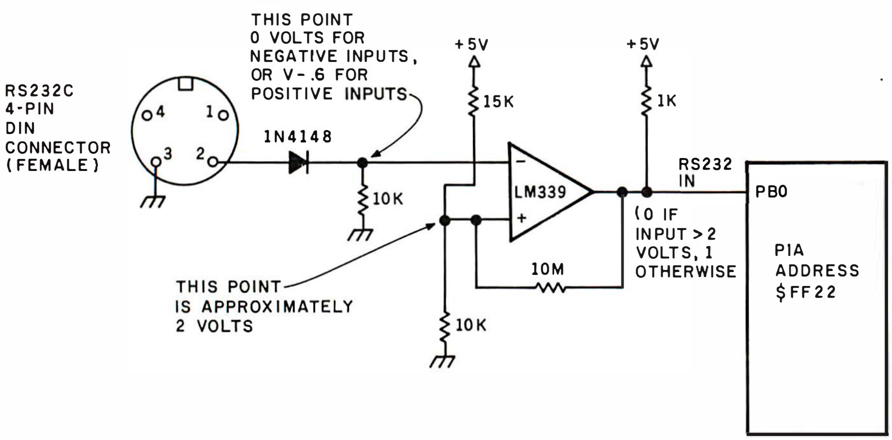


Figure 3: *The Color Computer RS-232C RD input goes to an LM339 comparator via a diode. Output of the comparator is a logic 0 for positive signals and a logic 1 for negative signals.*

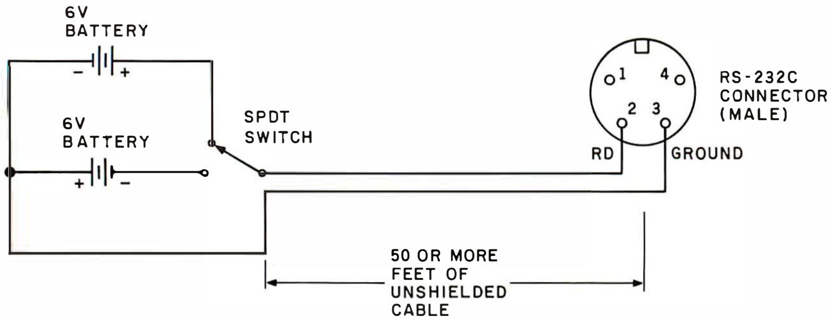


Figure 4: *Two 6-V batteries can be connected to an SPDT switch to implement a remote sensing switch connected to the Color Computer RS-232C port.*

and a 10-kΩ resistor. The junction point is a constant +2 volts (V) and goes to the "+" (plus) input.

The "−" (minus) input connects to the external RD line via a common diode and 10-kΩ resistor to ground. RS-232C signals are normally above +3 V (logic 0) or below −3 V (logic 1). When the RD line is more positive than about +2.6 V, the input forward-biases the diode, and the "−" input is greater than the "+" input, producing a logic 0 comparator output. When the RD line is negative, the diode is reverse-biased, and the output of the comparator is logic 1. The comparator output goes to bit 0 of a PIA whose address is hexadecimal FF22. Reading bit 0 of PIA hexadecimal FF22 is a process similar to reading the joystick switch, as shown in listing 2.

Figure 4 shows the connections for the RS-232C remote input. Tie the normally closed contact of the switch to the positive terminal of a 6-V battery. Tie the normally open contact of the switch to the negative terminal of a second battery. Tie the opposite ends of the batteries together and to the ground lead of the RS-232C connector. The common contact of the switch goes to the RD line. There will be some switch bounce when the switch is broken (on the order of 50 or 60 milliseconds [ms]), but this arrangement is fine for slow sensing.

Again, this scheme was implemented using ordinary two-conductor cable without termination and with a 60-foot run in a home environment. No false readings were detected. Twisted-pair cable could be used to increase the noise immunity. As this method is essentially current-driven rather than voltage driven, runs even longer than 60 feet should be possible.

Cassette input. Now for the third method of implementing a discrete input: using the cassette input. Examination of the Color Computer and Model III shows that the same scheme, a comparator input, is used for both the Color Computer and Model III 1500-bps (bits per second) cassette inputs. (The Model I and Model III 500-bps cassette inputs use



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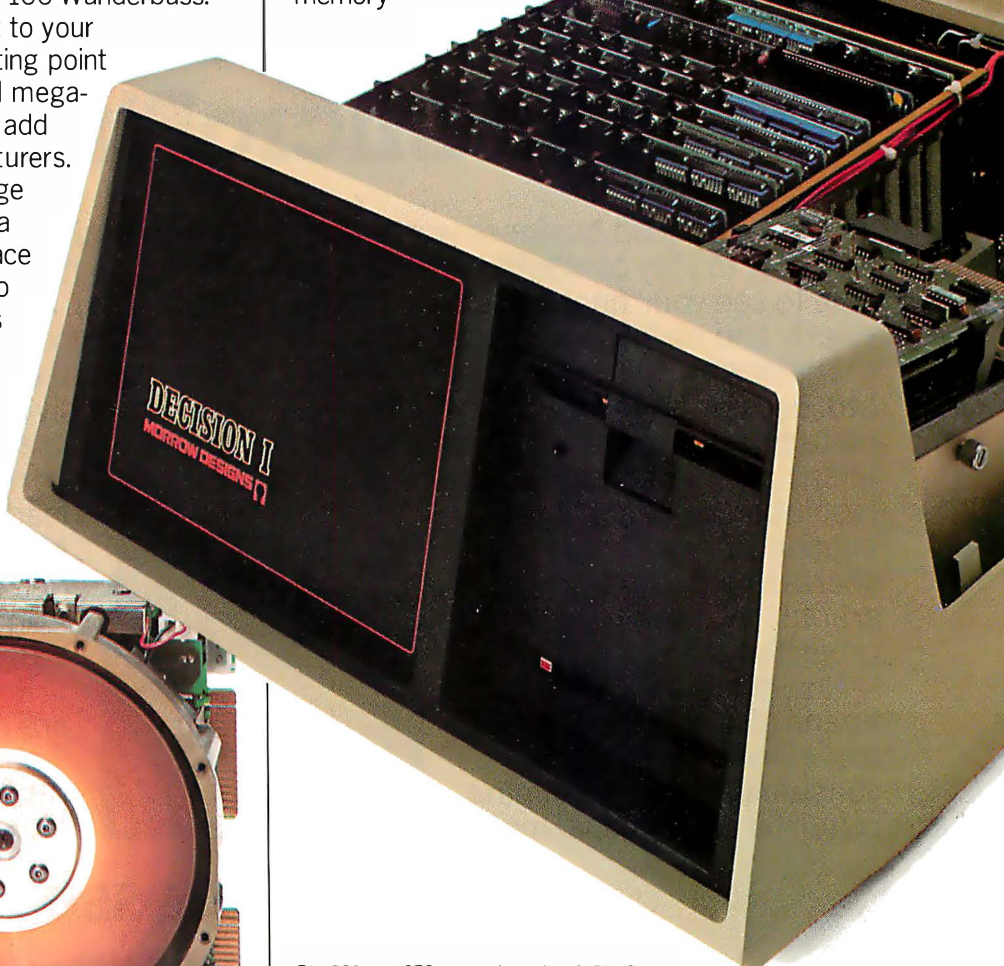
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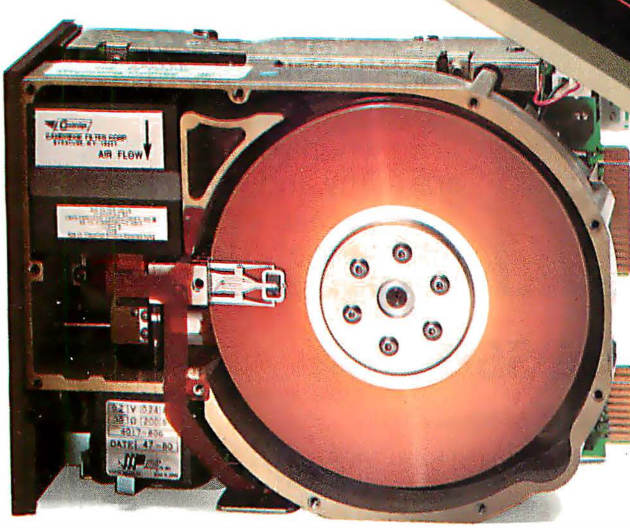
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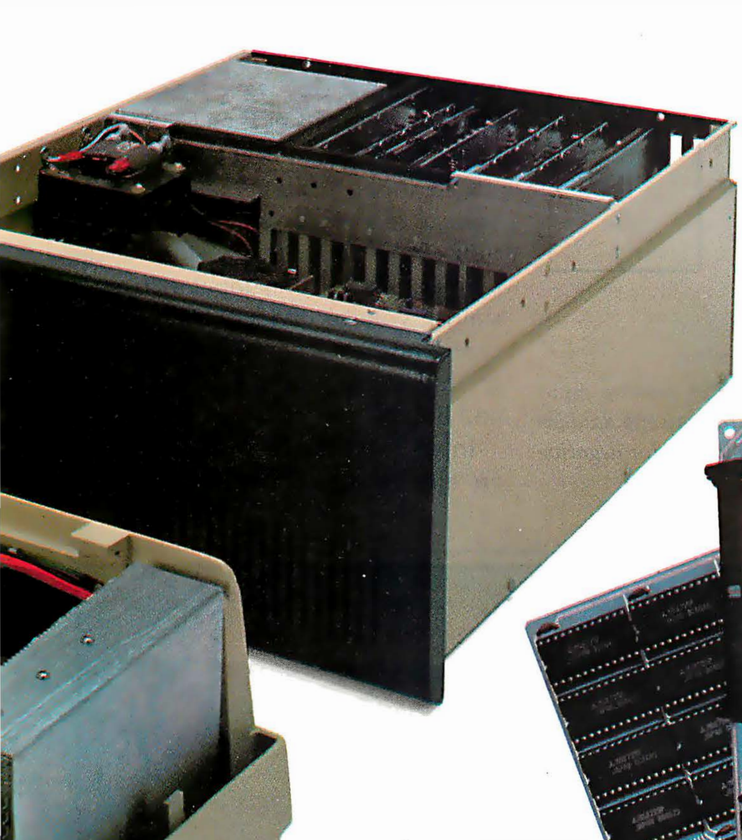


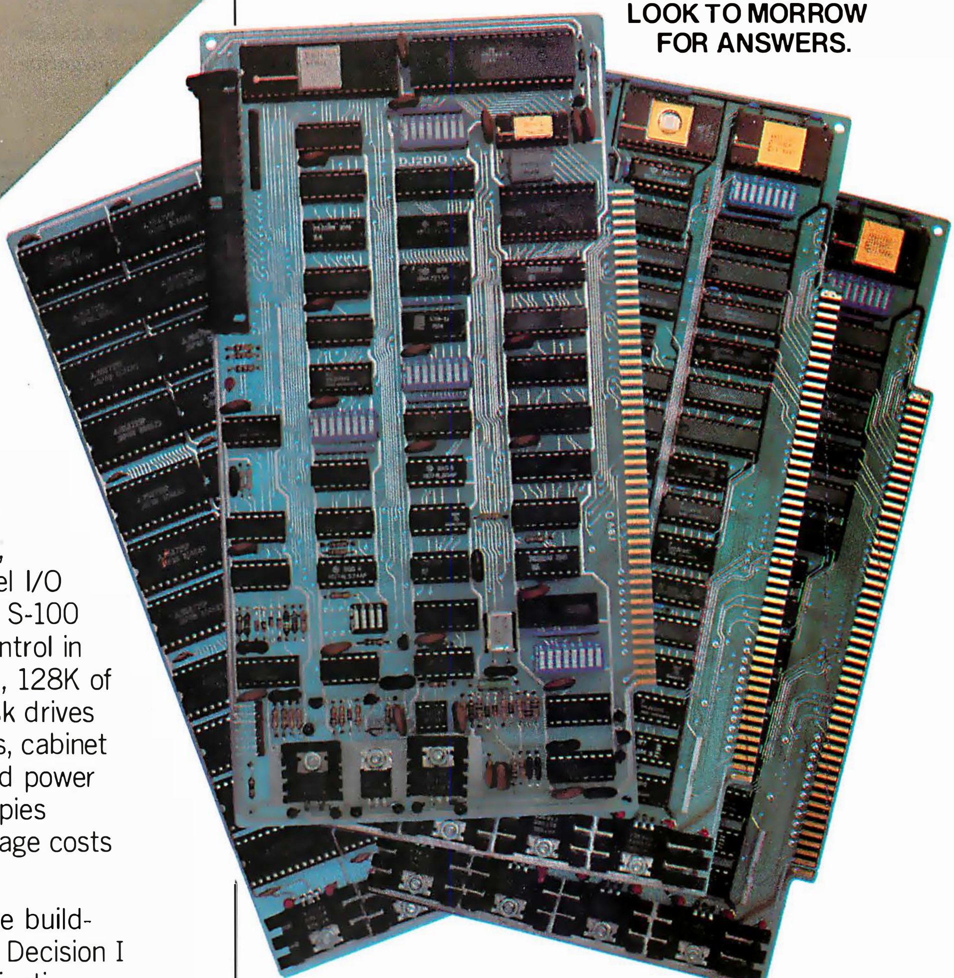


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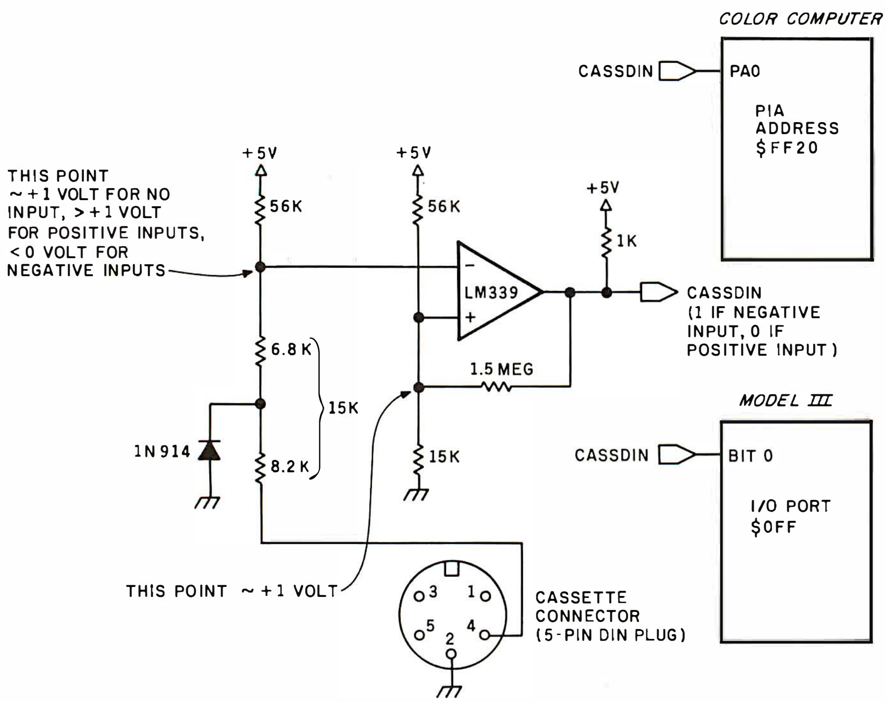


Figure 5: *The Color Computer and Model III have identical 1500-bps cassette input logic. An LM339 comparator compares a fixed reference voltage to the cassette data input. Output of the comparator is a logic 0 for positive signals and a logic 1 for negative signals.*

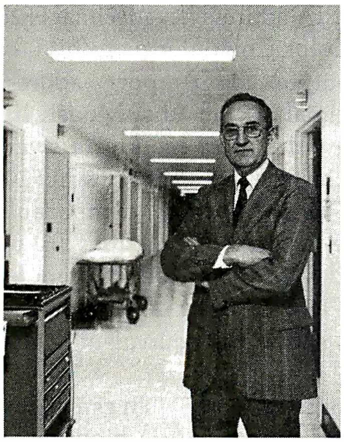
a different scheme, one of rectifying pulses. That arrangement is not as functional for random inputs as the one discussed here.) As a matter of fact, the input circuits in the Color Computer and Model III 1500-bps cassette interfaces are identical (see figure 5).

A frequency-shift keying method is used to generate the cassette waveform. A different frequency is used for a 0 and a 1 bit, as shown in figure 6. The Color Computer or Model III firmware measures the frequency of the sine wave by checking the binary output of the LM339 comparator, as shown in the figure.

One input to the LM339 is a fixed voltage of about +1 V from the junction of the 56-kΩ and 15-kΩ voltage divider. The second input is from a similar voltage divider. In the latter case, however, a diode goes to ground at the junction of the 6.8-kΩ and 8.2-kΩ resistors.

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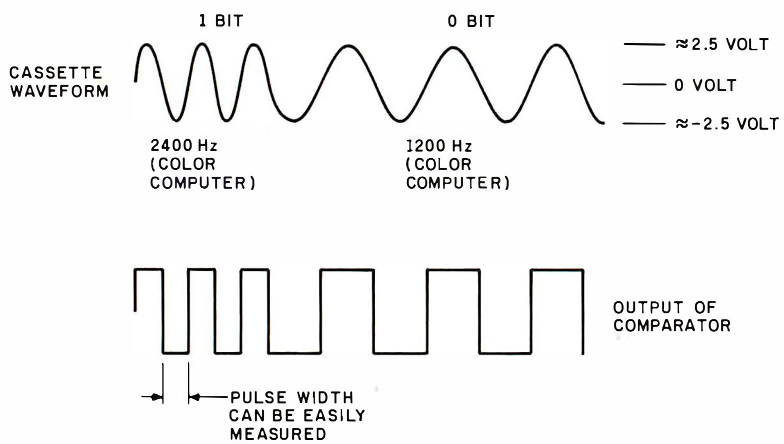


Figure 6: *Both the Color Computer and Model III 1500-bps cassette logics use a "frequency-shift keying" recording technique in which two separate frequencies represent logic 0 and 1.*

Listing 3: *Sample Color Computer BASIC program for reading cassette input.*

```
100 ' SWITCH CLOSURE FOR CASSETTE INPUT
110 A=(PEEK(&HFF20) AND 1)
120 IF A=0 THEN PRINT "OFF" ELSE PRINT "ON"
130 GOTO 110
```

Listing 4: *Sample Model III BASIC program for reading cassette input.*

```
100 ' SWITCH CLOSURE FOR CASSETTE INPUT
110 A=(INP(255) AND 1)
120 IF A=0 THEN PRINT "OFF" ELSE PRINT "ON"
130 GOTO 110
```

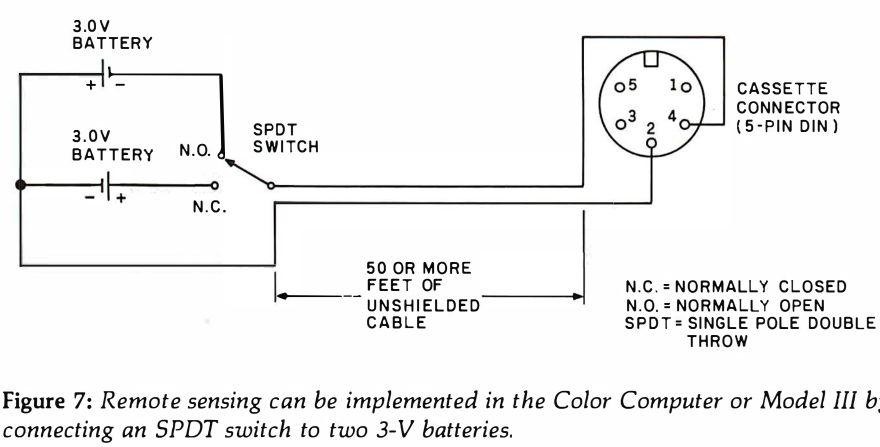


Figure 7: *Remote sensing can be implemented in the Color Computer or Model III by connecting an SPDT switch to two 3-V batteries.*

with about 2.5-V swings on either side of 0 V. When the cassette signal is positive, the "−" input is greater than +1 V, and the comparator output is logic 0. When the cassette signal is negative, the diode conducts, dropping the "−" input to below 0 V and forcing the comparator output to logic 1.

Output of the comparator goes to bit 0 of PIA address hexadecimal FF20 in the Color Computer or to bit 0 of input/output (I/O) port address hexadecimal FF in the Model III. Reading either port requires a single BASIC instruction (PEEK (&HFF20) or INP(255)) or a comparable machine-language instruction. Listing 3 provides a simple Color Computer BASIC test of the cassette-in bit; listing 4 shows the equivalent Model III test.

A remote sensing switch can be implemented in identical fashion to the RS-232C method, as shown in figure 7. Two batteries produce +3 V and −3 V, and these voltages are tied to the normally closed (NC) and normally open (NO) contacts of the remote sensing switch. The switch is connected via ordinary two-conductor cable. Again, twisted wires may be used if desired to improve noise immunity. A 60-foot length of cable was used in a home environment, and no false readings were detected for slow switch closures.

Switch Bounce

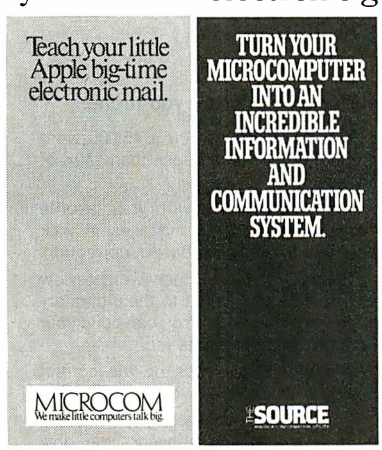
The BASIC programs listed for the three discrete input methods are fine for slowly changing inputs such as burglar alarms. A typical BASIC loop allows sampling at a dozen or so times per second. When the frequency of switch closures is greater, however, you must rely on faster assembly-language code. Assembly-language code can test the inputs thousands of times per second. In fact, assembly language is so fast that switch bounce can cause problems. The typical switches mentioned above do not close instantaneously. Minute movements produce "make and break" conditions during a certain period, as shown in figure 8.

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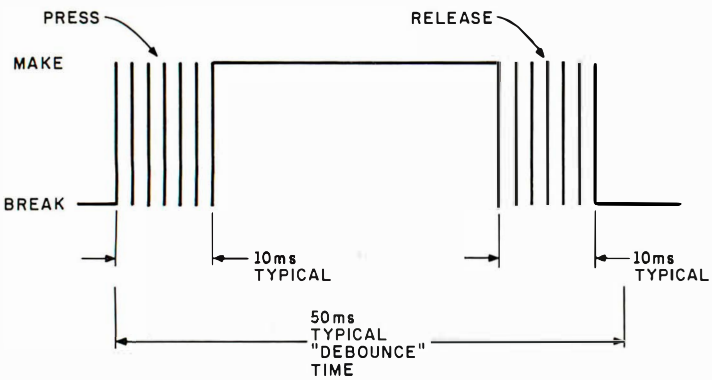


Figure 8: *Switch debounce can be accomplished in software by delaying a "debounce time" after initial detection of the switch closure.*

eliminate switch bounce, but let's seek software solutions instead. The usual software approach is to delay for a fixed interval after detection of the first switch closure.

The following table suggests debounce requirements. The two Radio Shack switches referred to previously were pressed rapidly for exactly 10 closures within about 2 seconds for various "debounce delays" ranging from 10 ms to 100 ms. The "count" represents the number of switch closures detected. Counts greater than 10 indicate that switch bounces were counted as closures.

Debounce Delay (ms)	Key Closures Detected
100	10
90	10
80	10
70	10
60	10
50	17
40	19
30	22
20	33
10	59

The switch-bounce delay in software varies with the type of switch and action of the operator. Use these figures as a rough guide only.

A Low-Frequency Event Counter

Listing 5 gives a low-frequency counter program for the Color Computer, one that will measure events occurring thousands of times per second. The discrete input is on the cassette input line and is designed to interface to a BASIC driver.

Three parameters are stored in high memory in a 16K-byte system. The first, an interval count, is stored in locations hexadecimal 3FFA and 3FFB. The interval count may be any number from 1 through 32,768 and represents the time window during which events will be counted in units of 30.35 microseconds (μs). An interval of 1000, for example, represents 30,350 μs or 30.35 ms. Maximum window time is 32,768 $\times$ 30.35 μs or .994508 second. (Note: for 32,768, use 0.)

The second parameter, a debounce delay count in milliseconds, is stored in locations hexadecimal 3FFC and 3FFD. This delay count will cause the program to "close" the window for a

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Listing 5: *Color Computer assembly-language program for measuring low frequencies through the cassette input port. Switch-debounce time can be varied.*

```
3F00                 00100        ORG     $3F00
                     00110 *****************************************************
                     00120 * LOW-FREQUENCY EVENT COUNTER WITH DEBOUNCE          *
                     00130 *   INPUT: $03FFA = INTERVAL CNT IN 30.35 MICROSEC *
                     00140 *          UNITS, 2 BYTES                           *
                     00150 *          $03FFC = DEBOUNCE DELAY CNT IN MS, 2 BY *
                     00160 *          $03FFE = RESERVED FOR COUNT, 2 BYTES     *
                     00170 *   OUTPUT: $03FFE = # OF COUNTS IN INTERVAL, 2 BYT *
                     00180 *****************************************************
                     00190 *
3F00 BE   3FFA       00200 LOWFRE  LDX     $3FFA    GET INTERVAL CNT
3F03 108E 0000       00210         LDY     #0       INITIALIZE COUNT
3F07 30   1F         00220 LOW010  LEAX    -1,X         DECREMENT INT CNT (5)
3F09 1F   10         00230         TFR     X,D          NOW IN D (7)
3F0B 4D              00240         TSTA                 TEST FOR NEGATIVE (2)
3F0C 2B   0D         00250         BMI     LOW090       GO IF DONE (3)
3F0E B6   FF20       00260         LDA     $FF20        GET PIA BYTE (5)
3F11 84   01         00270         ANDA    #1           GET CASSDIN BIT (2)
3F13 27   F2         00280         BEQ     LOW010       GO IF 0 (3)
3F15 31   21         00290         LEAY    1,Y         1, INCREMENT COUNT
3F17 8D   07         00300         BSR     DEBNC      DEBOUNCE DELAY
3F19 20   EC         00310         BRA     LOW010     CONTINUE INTERVAL
3F1B 10BF 3FFE       00320 LOW090  STY     $3FFE    STORE COUNT
3F1F 39              00330         RTS              RETURN FROM SUBROUTINE
                     00340 *
                     00350 * DEBOUNCE DELAY SUBROUTINE
                     00360 *
3F20 34   10         00370 DEBNC   PSHS    X        SAVE INTERVAL COUNT
3F22 BE   3FFC       00380         LDX     $3FFC    GET DELAY COUNT IN MS
3F25 8D   06         00390 DEB010  BSR     DELAY    DELAY N MS
3F27 30   1F         00400         LEAX    -1,X       DECREMENT DELAY COUNT
3F29 26   FA         00410         BNE     DEB010     GO IF NOT N MS
3F2B 35   90         00420         PULS    X,PC     RETRIEVE INTERVAL COUNT,RTN
                     00430 *
                     00440 * DELAY SUBROUTINE. DELAYS N MS.
                     00450 *
3F2D 34   10         00460 DELAY   PSHS    X        SAVE DELAY COUNT
3F2F 8E   006F       00470         LDX     #111     FINAGLE FACTOR
3F32 30   1F         00480 DEL010  LEAX    -1,X       DECREMENT FINAGLE COUNT
3F34 26   FC         00490         BNE     DEL010     LOOP FOR 1 MS
3F36 AE   64         00500         LDX     4,S      GET INTERVAL COUNT
3F38 30   88 DF      00510         LEAX    -33,X    ADJUST FOR 1 MS DELAY
3F3B AF   64         00520         STX     4,S      RESTORE IN STACK
3F3D 35   90         00530         PULS    X,PC     RETRIEVE COUNT, RTN
          0000       00540         END
00000 TOTAL ERRORS
```

Listing 6: *Model III assembly-language program for measuring low frequencies through the cassette input port. Switch-debounce time can be varied.*

```
7F00         00100           ORG     7F00H            ;THIS SR NON-RELOCATABLE
             00110 ;*****************************************************
             00120 ;* LOW-FREQUENCY EVENT COUNTER WITH DEBOUNCE            *
             00130 ;*   INPUT:   7FFAH = INTERVAL COUNT IN 26.86 MICROSEC  *
             00140 ;*            UNITS, 2 BYTES                            *
             00150 ;*            7FFCH = DEBOUNCE DELAY CNT IN MS, 2 BYTES *
             00160 ;*            7FFEH = RESERVED FOR COUNT, 2 BYTES       *
             00170 ;*   OUTPUT:  7FFEH = # OF COUNTS IN INTERVAL, 2 BYTES  *
             00180 ;*****************************************************
             00190 ;
7F00 F3      00191 LOWFRE  DI                         ;DISABLE INTERRUPTS
```

Listing 6 continued on page 178

TRS-80* COMPUTING EDITION

©1981 Percom Data Co., Inc. **The Percom Peripheral** 35 cents

Percom's DOUBLER II™ tolerates wide variations in media, drives

GARLAND, TEXAS — May 22, 1981 — Harold Mauch, president of Percom Data Company, announced here today that an improved version of the Company's innovative DOUBLER® adapter, a double-density plug-in module for TRS-80* Model I computers, is now available.

Reflecting design refinements based on both theoretical analyses and field testing, the DOUBLER II®, so named, permits even greater tolerance in variations among media and drives than the previous design.

Like the original DOUBLER, the DOUBLER II plugs into the drive controller IC socket of a TRS-80 Model I Expansion Interface and permits a user to run either single- or double-density diskettes on a Model I.

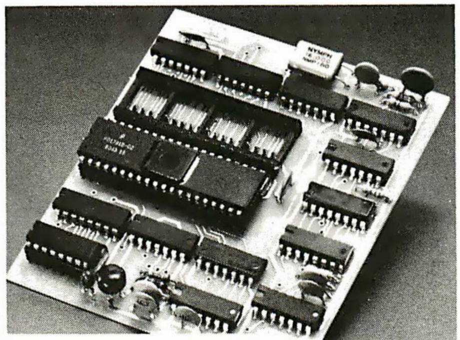
With a DOUBLER II installed, over four times more formatted data — as much as 364 Kbytes — can be stored on one side of a five-inch diskette than can be stored using a standard Tandy Model I drive system.

Moreover, a DOUBLER II equips a Model I with the hardware required to run Model III diskettes.

(*Ed. Note:* See "OS-80®: Bridging the TRS-80* software compatibility gap" elsewhere on this page.)

The critical clock-data separation circuitry of the DOUBLER II is a proprietary design *called a ROM-programmed digital phase-lock loop data separator.*

According to Mauch, this design is more tolerant of differences from diskette to diskette and drive to drive, and also provides *immunity to performance degradation caused by circuit component aging.*



Percom DOUBLER II®

Mauch said "A DOUBLER II will operate just as reliably two years after it is installed as it will two days after installation."

The digital phase-lock loop also *eliminates the need for trimmer adjustments typical of analog phase-lock loop circuits.*

"You plug in a Percom DOUBLER II and then forget it," he said.

The DOUBLER II also features a refined Write Precompensation circuit that more effectively minimizes the phenomena of bit- and peak-shifting, a reliability-impairing characteristic of magnetic data recording.

The DOUBLER II, which is fully software compatible with the previous DOUBLER, is supplied with DBLDOS®, a TRSDOS*-compatible disk operating system.

The DOUBLER II sells for ~~$219.95~~, including the DBLDOS diskette. NOW $169.95!

The Percom DOUBLER II is available from authorized Percom retailers, or may be ordered direct from the factory. The factory toll-free order number is 1-800-527-1222.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty. Circle 333 on inquiry card.

All that glitters is not gold

OS-80™ Bridging the TRS-80* software compatibility gap

Compatibility between TRS-80* Model I diskettes and the new Model III is about as genuine as a gold-plated lead Krugerrand.

True, Model I TRSDOS* diskettes can be *read* on a Model III. But first they must be converted and re-recorded for Model III operation.

And you *cannot write* to a Model I TRSDOS* diskette. Not with a Model III. You cannot add a file. Delete a file. Or in any way modify a Model I TRSDOS diskette with a Model III computer.

Furthermore, your converted TRSDOS diskettes cannot be converted *back* for Model I operation.

TRSDOS is a one-way street. And there's no re-treating. A point to consider before switching the company's payroll to your new Model III.

Real software compatibility should allow the *direct, immediate* interchangeability of Model I and Model III diskettes. No read-only limitations, no conversion/re-recording steps and no chance to be left high and dry with Model III diskettes that can't be run on a Model I.

What's the answer? The answer is Percom's OS-80™ family of TRS-80 disk operating systems.

OS-80 programs allow *direct, immediate* interchangeability of Model I and Model III diskettes.

You can run Model I single-density diskettes on a Model III; install Percom's plug-in DOUBLER™ adapter in your Model I, and you can run double-density Model III diskettes on a Model I.

There's no conversion, no re-recording.

Slip an OS-80 diskette out of your Model I and insert it directly in a Model III.

And vice-versa.

Just have the correct OS-80 disk operating system — OS-80, OS-80D or OS-80/III — in each computer.

Moreover, with OS-80 systems, you can add, delete, and update files. You can read *and write* diskettes regardless of the system of origin.

OS-80 is the original Percom TRS-80 DOS for BASIC programmers.

Even OS-80 utilities are written in BASIC.

OS-80 is the Percom system about which a user wrote, in Creative Computing magazine, "...the best $30.00 you will ever spend."†

Requiring only seven Kbytes of memory, OS-80 disk operating systems reside completely in RAM. There's no need to dedicate a drive exclusively for a system diskette.

And, unlike TRSDOS, you *can* work at the track sector level, defining and controlling data formats — in BASIC — to create simple or complex data structures that execute more quickly than TRSDOS files.

The Percom OS-80 DOS supports single-density operation of the Model I computer — price is $29.95; the OS-80D supports double-density operation of Model I computers equipped with a DOUBLER or DOUBLER II; and, OS-80/III — for the Model III of course — supports both single- and double-density operation. OS-80D and OS-80/III each sell for $49.95. Circle 334 on inquiry card.

Circuit misapplication causes diskette read, format problems.

High resolution key to reliable data separation

GARLAND, TEXAS — The Percom SEPARATOR® does very well for the Radio Shack TRS-80* Model I computer what the Tandy disk controller does poorly at best: *reliably* separates clock and data signals during disk-read operations.

Unreliable data-clock separation causes format verification failures and repeated read retries.

CRCERROR–TRACK LOCKED OUT

The problem is most severe on high-number (high-density) inner file tracks.

As reported earlier, the clock-data separation problem was traced by Percom to misapplication of the internal separator of the 1771 drive controller IC used in the Model I.

The Percom Separator substitutes a *high-resolution* digital data separator circuit, one which operates at 16 megahertz, for the low-resolution one-megahertz circuit of the Tandy design.

Separator circuits that operate at lower frequencies — for example, two- or four-megahertz — were found by Percom to provide only marginally improved performance over the original Tandy circuit.

The Percom solution is a simple adapter that plugs into the drive controller of the Expansion Interface (EI).

Not a kit — some vendors supply an untested separator kit of resistors, ICs and other paraphernalia that may be installed by modifying the computer — the Percom SEPARATOR is a fully assembled, fully tested plug-in module.

Installation involves merely plugging the SEPARATOR into the Model I EI disk controller chip socket, and plugging the controller chip into a socket on the SEPARATOR.

The SEPARATOR, which sells for only $29.95, may be purchased from authorized Percom retailers or ordered directly from the factory. The factory toll-free order number is 1-800-527-1222.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty. Circle 332 on inquiry card.

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PERCOM DATA COMPANY, INC. 11220 Pagemill Road Dallas, Texas 75243 (214) 340-7081

 †Creative Computing Magazine, June, 1980, page 26.

Listing 6 continued:

```
7F01 DD2AFA7F 00200          LD      IX,(7FFAH)      ;GET INTERVAL COUNT
7F05 01FFFF   00210          LD      BC,-1           ;FOR DECREMENTS
7F08 FD210000 00220          LD      IY,0            ;INITIALIZE COUNT
7F0C DD09     00230 LOW010   ADD     IX,BC               ;DECREMENT INT CNT(15)
7F0E D21F7F   00240          JP      NC,LOW090           ;GO IF DONE (10)
7F11 DBFF     00250          IN      A,(0FFH)            ;GET I/O BYTE (11)
7F13 E601     00260          AND     1                   ;GET CASSDIN BIT (7)
7F15 CA0C7F   00270          JP      Z,LOW010            ;GO IF 0 (10)
7F18 FD23     00280          INC     IY                ;INCREMENT COUNT
7F1A CD257F   00290          CALL    DEBNC             ;DEBOUNCE DELAY
7F1D 18ED     00300          JR      LOW010            ;CONTINUE INTERVAL
7F1F FD22FE7F 00310 LOW090   LD      (7FFEH),IY      ;STORE COUNT
7F23 FB       00311          EI                      ;ENABLE INTERRUPTS
7F24 C9       00320          RET                     ;RETURN FROM SR
              00330 ;
              00340 ; DEBOUNCE SUBROUTINE
              00350 ;
7F25 FDE5     00360 DEBNC    PUSH    IY              ;SAVE INTERVAL CNT
7F27 FD2AFC7F 00370          LD      IY,(7FFCH)      ;GET DEBOUNCE DELAY
7F2B CD357F   00380 DEB010   CALL    DELAY             ;DELAY N MS
7F2E FD09     00390          ADD     IY,BC             ;DECREMENT DELAY CNT
7F30 38F9     00400          JR      C,DEB010          ;GO IF NOT N MS
7F32 FDE1     00410          POP     IY              ;RETRIEVE INT COUNT
7F34 C9       00420          RET                     ;RETURN FROM SR
              00430 ;
              00440 ; DELAY SUBROUTINE. DELAYS N MS.
              00450 ;
7F35 215E00   00460 DELAY    LD      HL,94           ;FINAGLE FACTOR
7F38 09       00470 DEL010   ADD     HL,BC             ;DECREMENT FINAGLE CNT
7F39 DA387F   00480          JP      C,DEL010          ;LOOP FOR 1 MS
7F3C 11DBFF   00490          LD      DE,-37          ;ADJUSTMENT CONSTANT
7F3F DD19     00500          ADD     IX,DE           ;ADJUST FOR  1 MS DELAY
7F41 C9       00510          RET                     ;RETURN FROM SR
0000          00520          END
00000 Total errors
```

specified time after each pulse is detected. The number of events detected in the interval, the third parameter, is returned in locations hexadecimal 3FFE and 3FFF.

A similar program for the Model III is shown in listing 6. The three parameters are passed in locations hexadecimal 7FFA through 7FFF and represent the same variables. Because operation for the two programs is similar, I'll describe both in general terms.

The DELAY subroutine delays for 1 ms by a simple loop. An interval count is adjusted for the 1-ms delay in units of 30.35 or 26.86. The DEBNC surboutine gets the debounce delay parameter and calls DELAY to delay for the debounce time in units of 1 ms.

The "main-line" code is in LOWFRE. The interval count parameter is decreased by 1 each time through the main loop. When the interval count is decremented beyond 0, the interval is completed, and the subroutine returns to the BASIC program. If the interval count is not completed, the PIA or I/O port bit for CASSDIN is read. If the cassette bit is a logic 1, the count of pulses is increased by 1, and the DEBNC subroutine is called for the debounce delay.

These programs detect a logic 1 pulse, i.e., a negative voltage input. The input signal can be any switch closure occurring up to thousands of times per second. A typical example is a roller switch on a rotating cam shaft. A longer time window can be created by repeatedly calling the subroutine.

BASIC drivers for both versions are shown in listings 7 and 8. The machine-language forms of the program are contained within the BASIC program in DATA statements, and the programs are poked into high random-access memory (RAM) by the BASIC code. The BASIC program asks for the interval and debounce delay parameters, pokes them into the parameter block, then calls the machine-language subroutine. A running total of all counts is printed after each call. To see how the program works, connect a switch as shown in figure 7, then close the switch for various delay and interval times.

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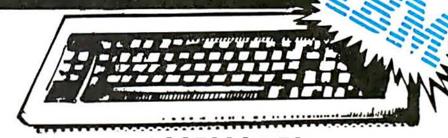
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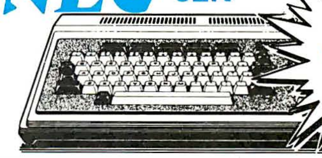
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Listing 7: *Color Computer BASIC driver program for LOWFRE. The machine-language code is included in the program and poked into high memory.*

```
100 ' LOWFRE DRIVER
110 DATA 190,63,250,16,142,0,0,48,31,31
120 DATA 16,77,43,13,182,255,32,132,1,39
130 DATA 242,49,33,141,7,32,236,16,191,63
140 DATA 254,57,52,16,190,63,252,141,6,48
150 DATA 31,38,250,53,144,52,16,142,0,111
160 DATA 48,31,38,252,174,100,48,136,223,175
170 DATA 100,53,144
180 FOR I=&H3F00 TO &H3F3E
190 READ A: POKE I,A
200 NEXT I
210 DEFUSR0=&H3F00
220 INPUT "INTERVAL, DELAY";IC,DC
230 POKE &H3FFA,INT(IC/256):POKE &H3FFB,IC-INT(IC/256)*256
240 POKE &H3FFC,INT(DC/256):POKE &H3FFD,DC-INT(DC/256)*256
250 A=USR0(0)
260 B=B+PEEK(&H3FFE)*256+PEEK(&H3FFF):PRINT B
270 GOTO 250
```

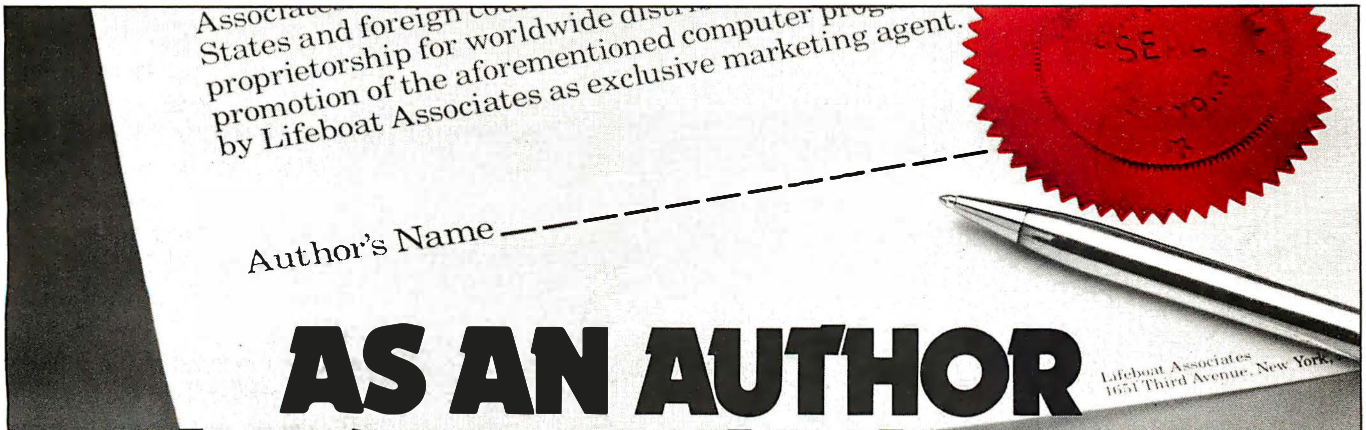
Listing 8: *Model III BASIC driver program for LOWFRE. The machine-language code is included in the program and poked into high memory.*

```
100 ' LOWFRE DRIVER
110 DATA 243,221,42,250,127,1,255,255,253,33
120 DATA 0,0,221,9,210,31,127,219,255,230
130 DATA 1,202,12,127,253,35,205,37,127,24
140 DATA 237,253,34,254,127,251,201,253,229,253
150 DATA 42,252,127,205,53,127,253,9,56,249
160 DATA 253,225,201,33,94,0,9,218,56,127
170 DATA 17,219,255,221,25,201
180 FOR I=32512 TO 32577
190 READ A:POKE I,A
200 NEXT I
210 DEFUSR0=&H7F00
220 INPUT "INTERVAL, DELAY"; IC,DC
230 POKE &H7FFA,IC-INT(IC/256)*256:POKE &H7FFB,INT(IC/256)
240 POKE &H7FFC,DC-INT(DC/256)*256:POKE &H7FFD,INT(DC/256)
250 A=USR0(0)
260 B=B+PEEK(&H7FFE)+PEEK(&H7FFF)*256: PRINT B
270 GOTO 250
```

describe a plumbing/electronics project—an anemometer. All parts can be purchased at your local hardware store and Radio Shack. The anemometer will measure a wide range of wind speeds and is easy to construct. Best of all, the entire project costs less than $10.

The plumbing. The physical appearance of the anemometer is detailed in figure 9. It's constructed with common 1-inch and ½-inch poly vinyl chloride (PVC) sprinkler fittings, wooden dowels, and plastic cups. Necessary parts are listed in table 1. To asemble the unit, refer to figure 10 and proceed as outlined in steps 1 through 19.

1. Cut a piece of 1-inch PVC thick-wall tubing to a length of 4 inches. (Any saw will do, but a hacksaw is best.)
2. Drill a hole in a 1-inch cap just large enough to pass a ½-inch PVC tube without friction.
3. Cement the cap to the 4-inch piece of tubing from step 1. Push the cap firmly down on the tube.
4. Drill a 3/16-inch hole completely through the cap abut ½-inch up from the bottom of the cap.
5. File off any projections from the bottom of a ½-inch cap.
6. Drill a small, centered hole in the cap and push in a decorative nail having a rounded head. It should fit snugly.
7. Cement the cap to a 6-inch piece of thin-wall ½-inch PVC tubing.
8. Push the ½-inch tubing from step 7 through the hole in the 1-inch



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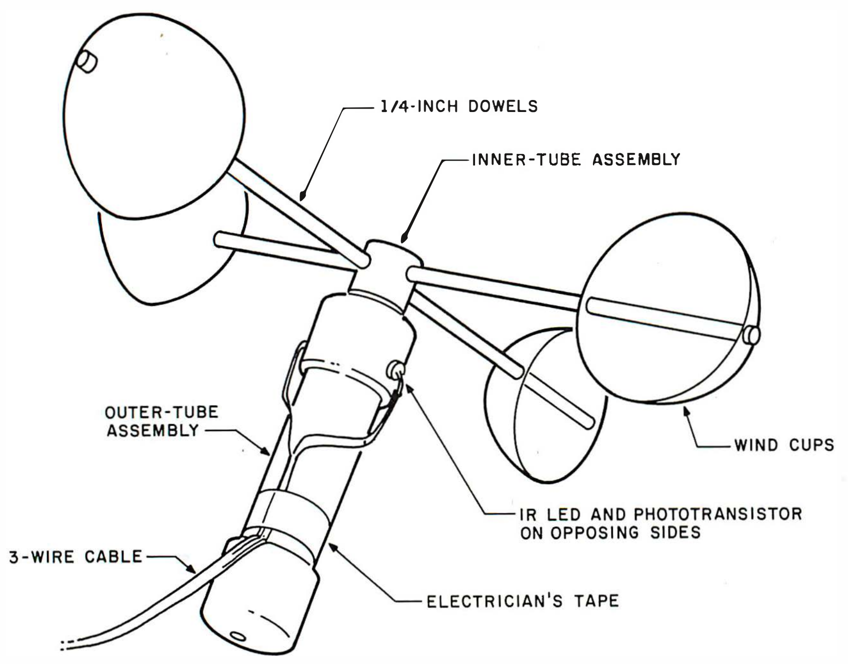


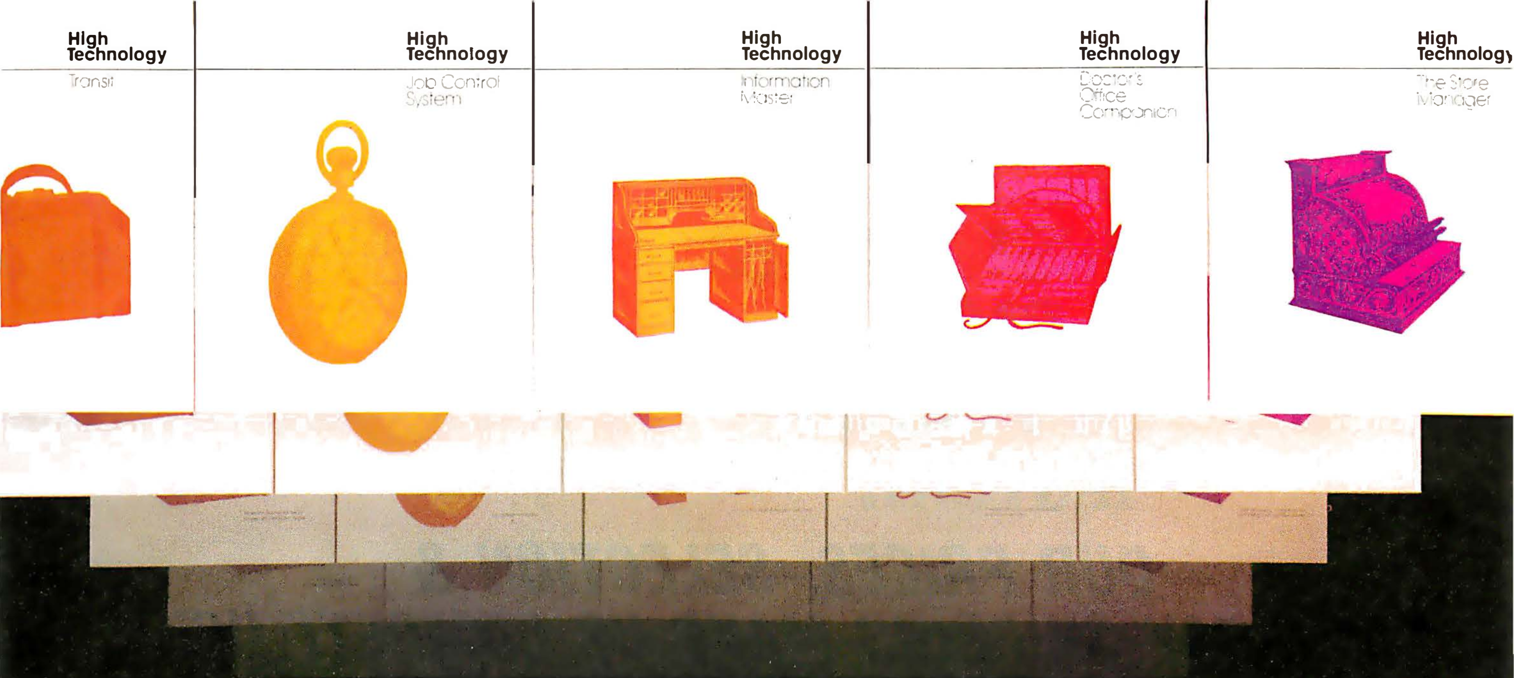
Figure 9: *A working anemometer can be easily constructed by using common materials (and a $600 or $1000 computer).*

Quantity	Description
1	4-inch piece of 1-inch PVC thick-wall tubing
2	1-inch slip caps
2	1/2-inch slip caps
1	6-inch piece of 1/2-inch thin-wall tubing
1	round-head nail or small screw
3 ft	1/4-inch wooden doweling
4	plastic, low-mass cups (halves of plastic ball or toy)
1	container of PVC cement
1	suitable mounting hardware for mast

Table 1: *Anemometer parts list.*

cap. Now cement a second 1-inch cap over the 1-inch tube. (Put two 1/8-inch drain holes in the bottom of the second cap.) Do not push the cap on all the way. The inner 1/2-inch tube should move as freely as possible.

9. After the cement has dried for an hour, drill a 3/16-inch hole through the inner tube, using the existing hole as a guide. Hold the tubes up to the light. The holes in the tubes should match. If not, drill out the inner tube again.
10. Drill two 1/4-inch holes completely through a 1/2-inch cap. The holes should be at right angles to each other and as close to the top of the cap as possible. The bottom hole should clear the path of the top hole.
11. Cut two 1/4-inch wood dowels to 14 inches. Push through the holes in the cap. Center the dowels.
12. Cement the dowels if they don't fit tightly.
13. Mount four plastic half-spheres (cups) on the four dowels. All four should present the same face to the wind.
14. Align and cement the plastic cups.
15. After the cement has dried, temporarily mount the cup assembly on the inner tube. Cut off enough of the inner tube to that the bot-



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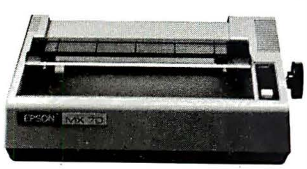
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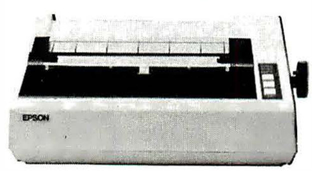
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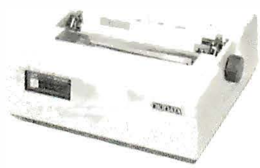
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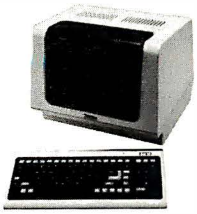


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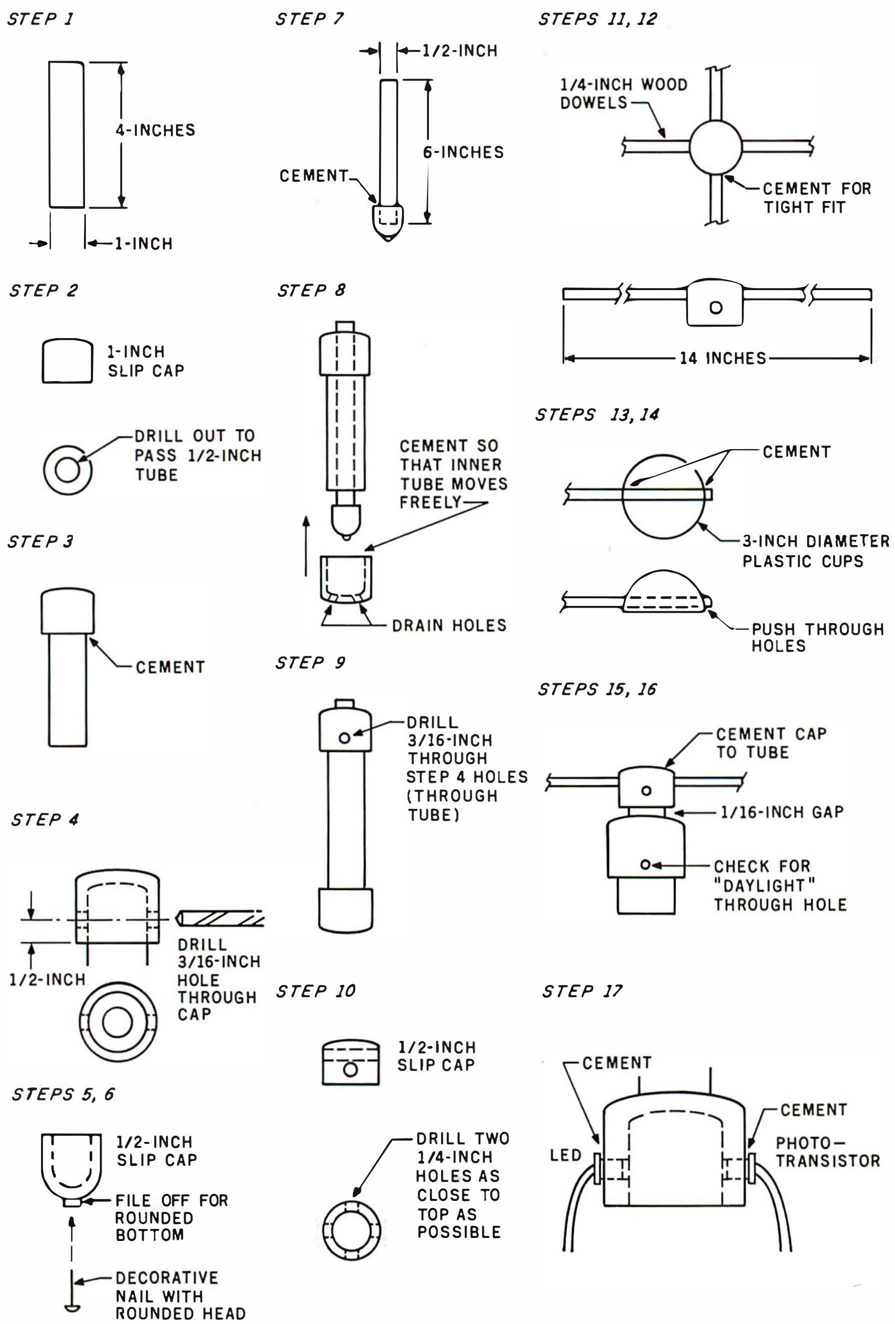


Figure 10: *Construction details of the anemometer. Total construction time is approximately one hour if all parts are on hand.*

Quantity	Description
1	150-ohm ¼-watt 10% tolerance resistor
1	1-kilohm ¼-watt 10% tolerance resistor
1	100-kilohm ¼-watt 10% tolerance resistor
1	4.7-kilohm ¼-watt 10% tolerance resistor
1	560-ohm ¼-watt 10% tolerance resistor
1	741C op-amp (Radio Shack 276-007)
1	Infrared LED (Radio Shack XC880-A, 276-143)
1	Infrared phototransistor (Radio Shack 276-145)
2	6-V batteries or 8 "C" cells in assembly
1	Wire, cable, solder
1	Project board (Radio Shack 276-175)
1	DIN plug, 5-pin (Radio Shack 274-003)

Table 2: *Anemometer electronics parts list.*

tom of the inner tube cap is about $\frac{1}{16}$ inch from the top of the 1-inch cap. Cement the cup assembly to the inner tube.

16. Again, check the hole alignment of the inner and outer tubes. Redrill the inner tube if necessary.
17. Press-fit the phototransistor and light-emitting diode (LED) into the two holes. Bring down the two leads from each. Cement the components in place using a bead of PVC cement around the edges.
19. Spin the cup assembly. It should move very freely, even in a light wind. You should be able to spin it by gently blowing at a cup at a distance of about a foot.

The electronics. The electronics assembly is built on a Radio Shack project board. The arrangement of the parts is shown in figure 11, and a parts list is given in table 2. Make a cable assembly of four wires and route to the anemometer. Solder the four cable wires to the LED and phototransistor as shown in figure 12.

After soldering the cable wires, wrap a piece of plastic electrical tape around the cable and tubing for strain relief. Put a dab of PVC cement on each solder joint and exposed lead. This will waterproof the connections.

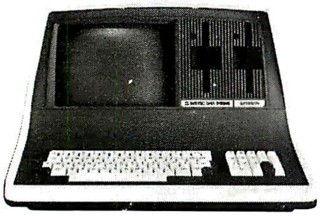
The circuit for the electronics is shown in figure 13. The electronics produce a +6-V or −6-V signal to the cassette input line. The 741C operational amplifier (op-amp) compares a voltage at the "−" input that is about 82 percent of the positive supply voltage. If the input voltage on the "+" lead drops below this level, the output of the op-amp is −6 V; otherwise it is +6 V.

When the two holes in the anemometer tubing are aligned, the infared light from the LED strikes the phototransistor and causes current to flow through it. When enough current flows, the "+" input drops below the 82 percent level and the op-amp output drops to −6 V. When no light is striking the phototransistor, no current flows through it, the "+" input is +6 V, and the op-amp output is +6 V. Place the anemometer assembly in a location that's shady yet exposed to the wind. (Don't

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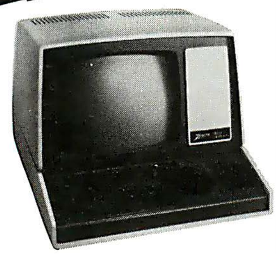
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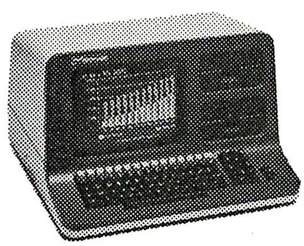
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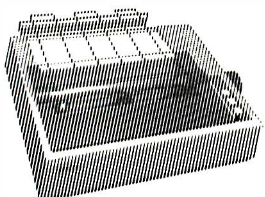


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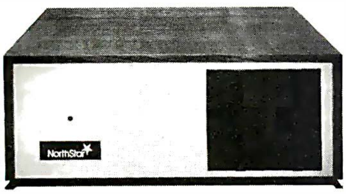
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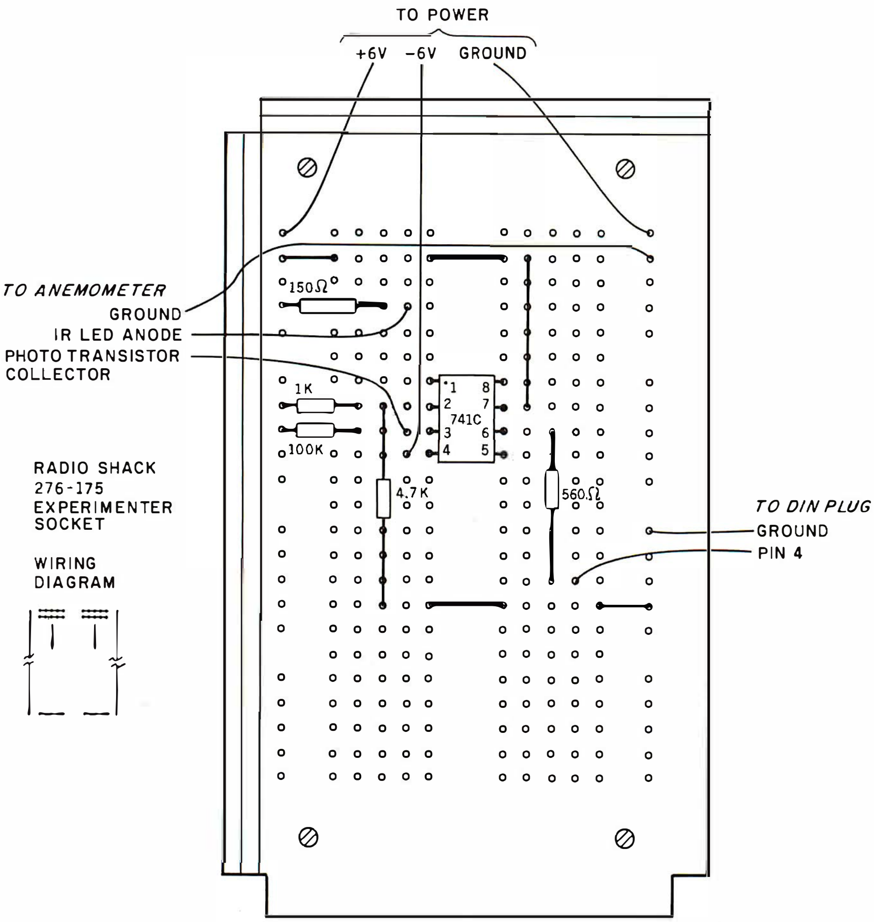


Figure 11: *The electronics portion of the anemometer uses a small project board for easy circuit assembly. Three sets of wires go to power connections, the anemometer, and the cassette input plug.*

mount it on a 200-foot tower until after additional testing, however.)

A PERIOD program. Listings 9 and 10 show PERIOD programs for the Color Computer and Model III, respectively. The PERIOD programs are used with the anemometer, but they are also general-purpose programs for measuring the period of any input signal that does not have to be debounced. The period is measured from the first negative-going transition to the next negative-going transition in 20.23- or 24.33-μs units. The period is passed back to a BASIC driver in locations hexadecimal 3FFE and 3FFF (Color Computer) or as the value of the USR function (Model III).

Listings 11 and 12 show the PERIOD programs incorporated as DATA statements in BASIC drivers. The machine-language code is located in high memory in both cases.

Using the anemometer. Protect high memory in the Color Computer by a CLEAR 200,&H3EFF. Protect high memory in the Model III by inputting a MEMORY SIZE of 32511. Load the BASIC Anemometer program, connect the cassette input to the electronics, connect the electronics power, and run the program.

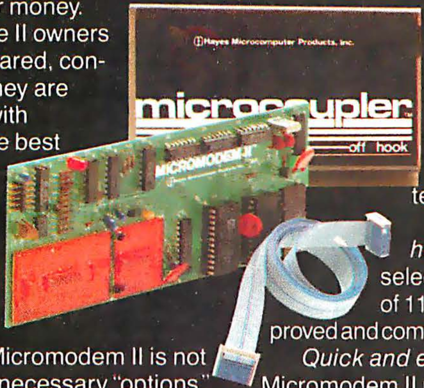
The program measures the period for the rotating anemometer. If no

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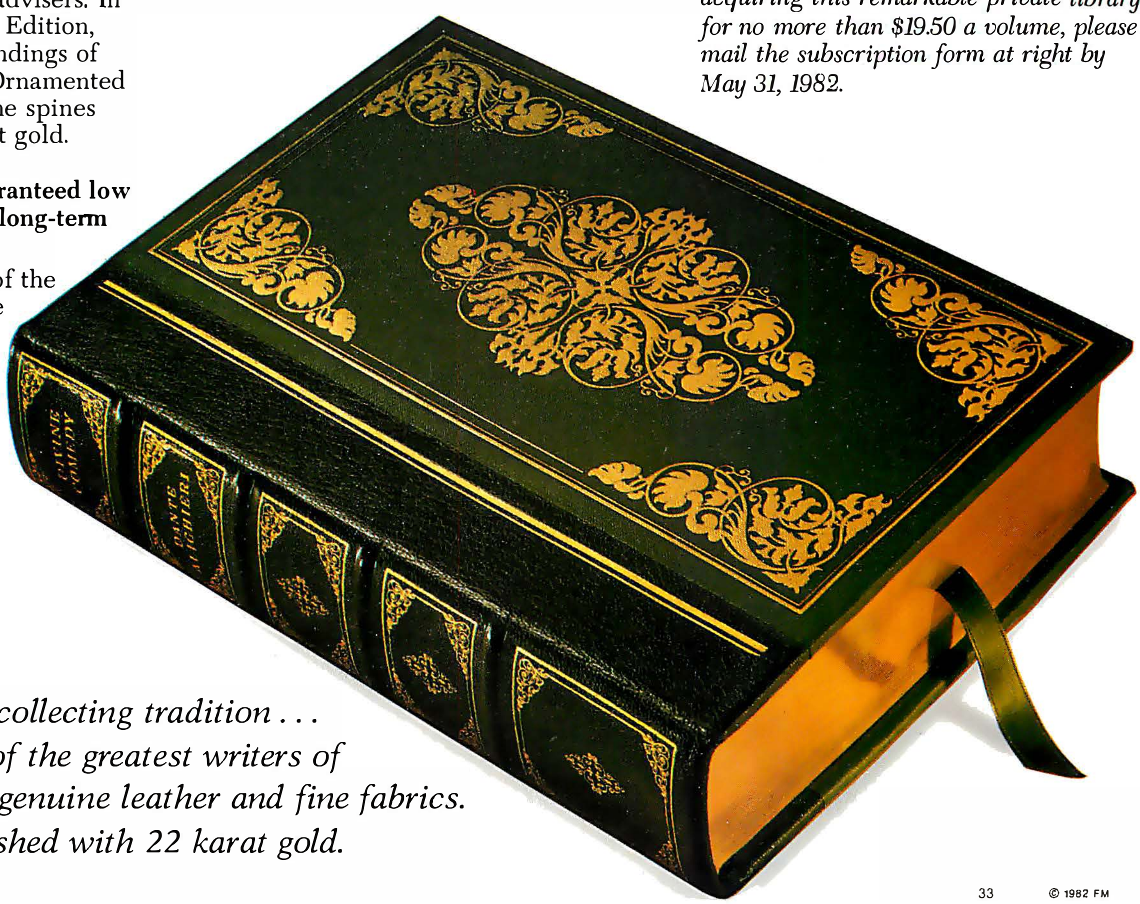
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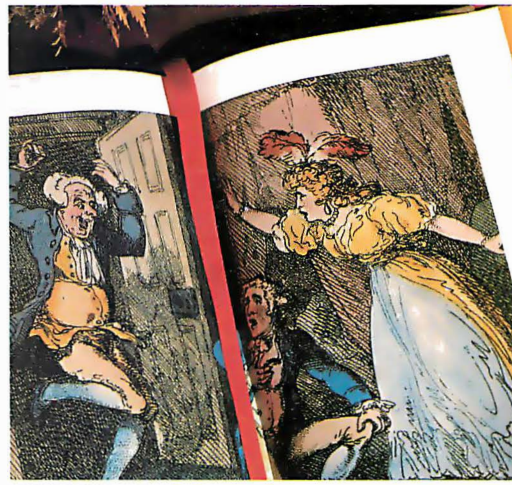
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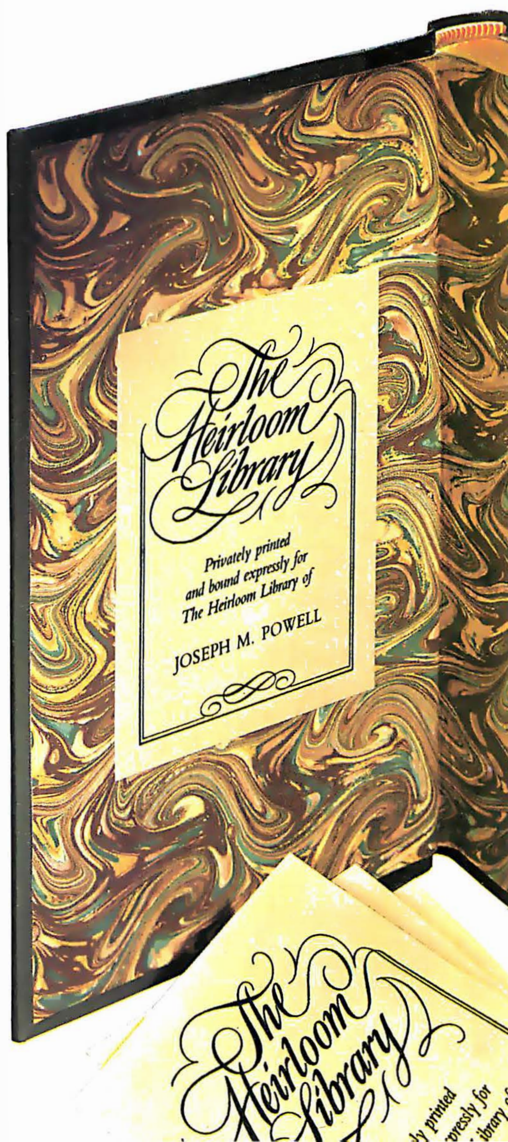


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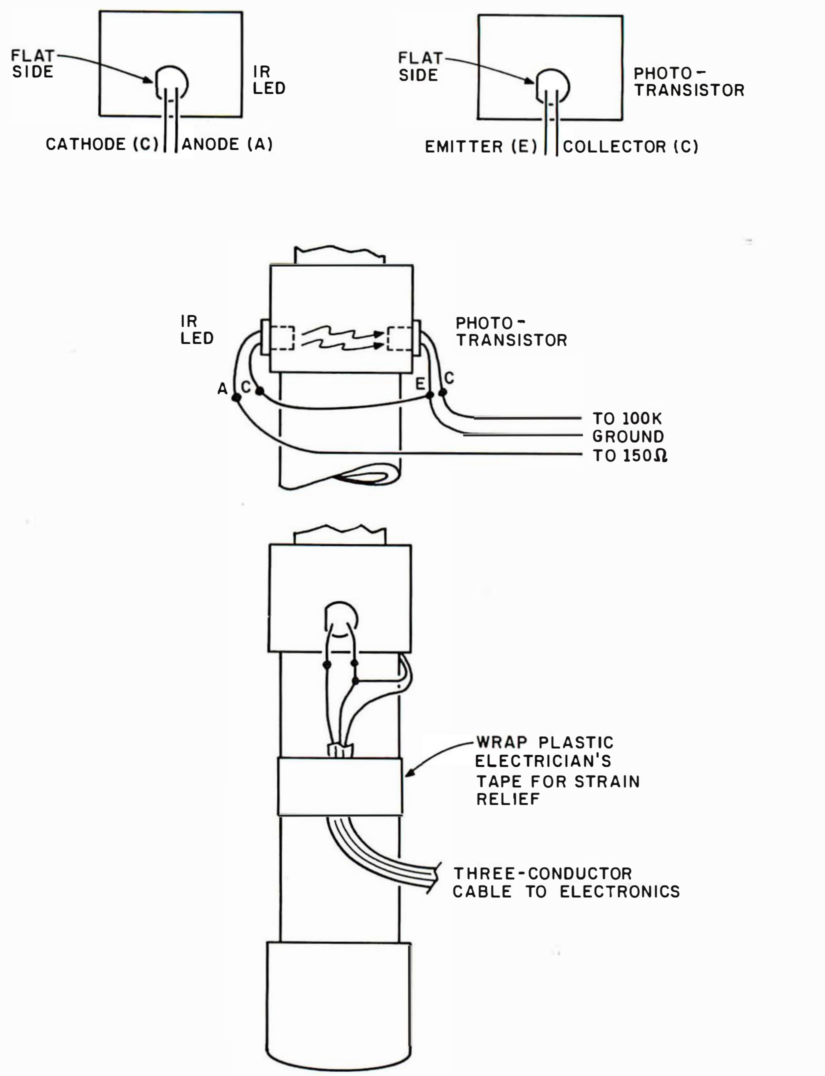


Figure 12: *The infrared LED and phototransistor are mounted on opposite sides of the anemometer shaft. Each shaft revolution produces two infrared light detections.*

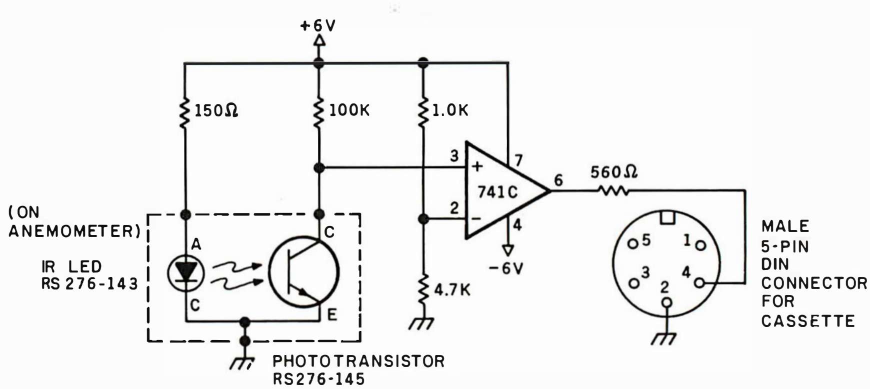


Figure 13: *The electronics portion of the anemometer uses a few simple components but can provide a precise measurement of anemometer rotation speed.*

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Listing 9: *Color Computer assembly-language program to measure the period of a cassette input signal.*

```
3F00                00100          ORG     $3F00
                    00110 ****************************************************
                    00120 * SUBROUTINE TO MEASURE PERIOD OF LOW-FREQ SIGNAL  *
                    00130 *   INPUT:  NIL                                    *
                    00140 *   OUTPUT: 3FFEH=PERIOD IN 20.23 MICROSECOND UNITS *
                    00150 *           OR -1 IF TIME OUT, 2 BYTES             *
                    00160 ****************************************************
                    00170 *
3F00 8E   0000      00180 PERIOD LDX    #0      TIME OUT COUNT
3F03 30   01        00190 PER010 LEAX   1,X       INCREMENT TIME OUT CNT
3F05 27   30        00200        BEQ    PER090    GO IF TIME OUT
3F07 B6   FF20      00210        LDA    $FF20     GET PIA BYTE
3F0A 84   01        00220        ANDA   #1        GET CASSDIN
3F0C 26   F5        00230        BNE    PER010    GO IF AT PULSE
3F0E 8E   0000      00240        LDX    #0      INITIALIZE TIME OUT CNT
3F11 30   01        00250 PER020 LEAX   1,X       INCREMENT TIME OUT CNT
3F13 27   22        00260        BEQ    PER090    GO IF TIME OUT
3F15 B6   FF20      00270        LDA    $FF20     GET PIA BYTE
3F18 84   01        00280        ANDA   #1        GET CASSDIN
3F1A 27   F5        00290        BEQ    PER020    GO IF NOT PULSE
3F1C 8E   0000      00300        LDX    #0      INITIALIZE TIME OUT
3F1F 30   01        00310 PER030 LEAX   1,X       INCREMENT TIME OUT CNT
3F21 27   14        00320        BEQ    PER090    GO IF TIME OUT
3F23 B6   FF20      00330        LDA    $FF20     GET PIA BYTE
3F26 84   01        00340        ANDA   #1        GET CASSDIN
3F28 26   F5        00350        BNE    PER030    GO IF STILL PULSE
3F2A 30   01        00360 PER050 LEAX   1,X       INCREMENT TIME COUNT
3F2C 27   09        00370        BEQ    PER090    GO IF TIME OUT
3F2E B6   FF20      00380        LDA    $FF20     GET PIA BYTE
3F31 84   01        00390        ANDA   #1        GET CASSDIN
3F33 27   F5        00400        BEQ    PER050    GO IF NOT END
3F35 20   03        00410        BRA    PER095  NORMAL RETURN
3F37 8E   FFFF      00420 PER090 LDX    #-1     FLAG TIME OUT
3F3A BF   3FFE      00430 PER095 STX    $3FFE   RETURN WITH ARGUMENT
3F3D 39             00440        RTS            RETURN
          0000      00450        END
00000 TOTAL ERRORS
```

Listing 10: *Model III assembly-language program to measure the period of a cassette input signal.*

```
7F00           00100        ORG     7F00H          ;RELOCATABLE
               00110 ;****************************************************
               00120 ;* SUBROUTINE TO MEASURE PERIOD OF LOW-FREQ SIGNAL  *
               00130 ;*   INPUT:  NIL                                    *
               00140 ;*   OUTPUT: HL=PERIOD IN 24.33 MICROSECOND UNITS   *
               00150 ;*           OR -1 IF TIME OUT, 2 BYTES             *
               00160 ;****************************************************
               00170 ;
7F00 210000    00180 PERIOD LD  HL,0           ;TIME OUT COUNT
7F03 010100    00190        LD  BC,1           ;INCREMENT
7F06 09        00200 PER010 ADD HL,BC            ;INCREMENT TIME OUT CNT
7F07 3829      00210        JR  C,PER090         ;GO IF TIME OUT
7F09 DBFF      00220        IN  A,(0FFH)         ;GET I/O BYTE
7F0B E601      00230        AND 1                ;GET CASSDIN
7F0D 20F7      00240        JR  NZ,PER010        ;GO IF AT PULSE
7F0F 210000    00250        LD  HL,0           ;REINITIALIZE TIME OUT CNT
7F12 09        00260 PER020 ADD HL,BC            ;INCREMENT TIME OUT COUNT
7F13 381D      00270        JR  C,PER090         ;GO IF TIME OUT
```

Listing 10 continued on page 198

Listing 10 continued:

```
7F15 DBFF      00280        IN    A,(0FFH)     ;GET I/O BYTE
7F17 E601      00290        AND   1            ;GET CASSDIN
7F19 28F7      00300        JR    Z,PER020     ;GO IF NOT PULSE
7F1B 210000    00310        LD    HL,0         ;REINITIALIZE TIME OUT
7F1E 09        00320 PER030 ADD   HL,BC        ;INCREMENT TIME OUT
7F1F 3811      00330        JR    C,PER090     ;GO IF TIME OUT
7F21 DBFF      00340        IN    A,(0FFH)     ;GET I/O BYTE
7F23 E601      00350        AND   1            ;GET CASSDIN
7F25 20F7      00360        JR    NZ,PER030    ;GO IF STILL PULSE
7F27 09        00370 PER050 ADD   HL,BC        ;INCREMENT TIME OUT
7F28 3808      00380        JR    C,PER090     ;GO IF TIME OUT
7F2A DBFF      00390        IN    A,(0FFH)     ;GET I/O BYTE
7F2C E601      00400        AND   1            ;GET CASSDIN
7F2E 28F7      00410        JR    Z,PER050     ;GO IF NOT END
7F30 1803      00420        JR    PER095       ;NORMAL RETURN
7F32 21FFFF    00430 PER090 LD    HL,-1        ;FLAG TIME OUT
7F35 C39A0A    00440 PER095 JP    0A9AH        ;PASS ARGUMENT BACK
0000           00450        END
00000 Total errors
```

Listing 11: *Color Computer BASIC driver program for the anemometer. This program uses the PERIOD program. The machine-language code for PERIOD is contained in the BASIC program and is poked into high memory.*

```
100 'SAMPLE ANEMOMETER PROGRAM
110 DATA 142,0,0,48,1,39,48,182,255,32
120 DATA 132,1,38,245,142,0,0,48,1,39,34
130 DATA 182,255,32,132,1,39,245,142,0,0
140 DATA 48,1,39,20,182,255,32,132,1,38
150 DATA 245,48,1,39,9,182,255,32,132,1,39
160 DATA 245,32,3,142,255,255,191,63,254,57
170 FOR I=&H3F00 TO &H3F3D
180 READ A: POKE I,A
190 NEXT I
200 DEFUSR0=&H3F00
210 CLS
220 A=USR(0)
230 A=PEEK(&H3FFE)*256+PEEK(&H3FFF)
240 IF A=65535 THEN A=0: GOTO 260
250 A=3.75/(A*20.23E-6)
260 PRINT @262,A;"MPH        "
270 GOTO 220
```

Listing 12: *Model III BASIC driver program for the anemometer. This program uses the PERIOD program. The machine-language code for PERIOD is contained in the BASIC program and is poked into high memory.*

```
1100 'SAMPLE ANEMOMETER PROGRAM MODEL III
110 DATA 33,0,0,1,1,0,9,56,41,219
120 DATA 255,230,1,32,247,33,0,0,9,56
130 DATA 29,219,255,230,1,40,247,33,0,0
140 DATA 9,56,17,219,255,230,1,32,247,9
150 DATA 56,8,219,255,230,1,40,247,24,3
160 DATA 33,255,255,195,154,10
170 FOR I=32512 TO 32567
180 READ A: POKE I,A
190 NEXT I
200 DEFUSR0=&H7F00
210 CLS
220 A=USR(0)
230 IF A=-1 THEN A=0:GOTO 250
235 IF A<0 THEN A=65536+A
240 A=3.75/(A*24.33E-6)
250 PRINT @ 532,A;"MPH          "
260 GOTO 220
```

rotation is detected, a −1 is returned as the period; both BASIC programs look for this flag and set the period to 0 in this case.

Wind speed will be displayed in the center of the screen. Wind speed in this case is a rough calculation based on preliminary empirical tests. The tests involved driving madly down city streets while keeping one eye on the road and the other on the rotating anemometer held at arm's length out the open car window. The 12-V DC-powered inverter for mobile computer operation is a project I'll leave for you in your spare time.

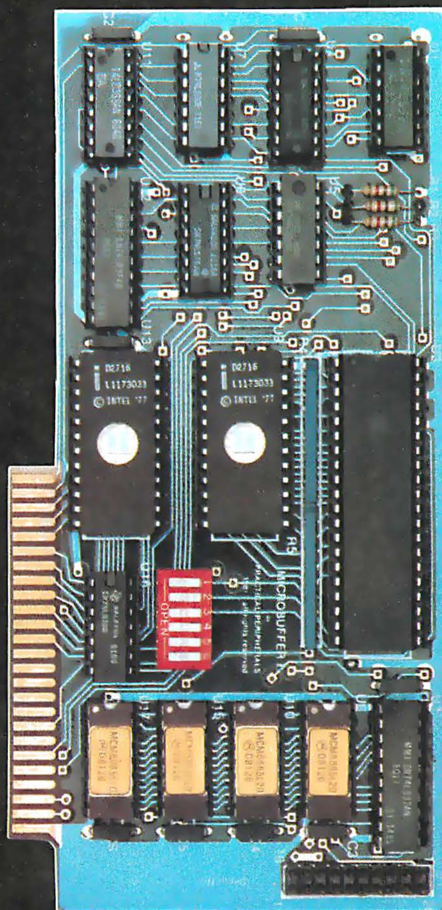
Each rotation of the shaft produces two pulses. A wind speed of 15 miles per hour (mph) is approximately 2 revolutions per second—thus the "3.75" factor. Rotational speed of the anemometer appears to be linear; 30-mph wind produces 4 revolutions per second and so forth. I would be very interested to hear from readers who construct the anemometer and run some tests with it, especially those who have access to a wind tunnel.

The above examples illustrate what can be achieved without a great deal of additional hardware when using inputs that were not meant to be discrete inputs but were dragged, kicking and screaming, into duty. In a later article, I'll look at a more sophisticated way to interface many lines to the system bus. I promise you won't be cutting up PVC tubing and scrubbing cement off your hands. ■

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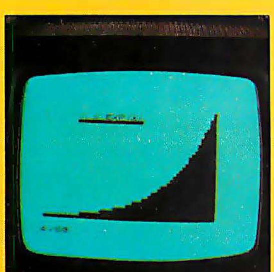
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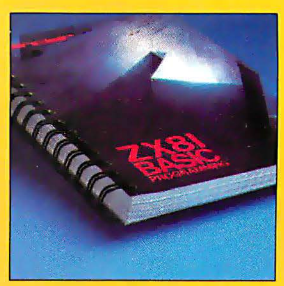
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The Input/Output Primer

Part 4: The BCD and Serial Interfaces

A look at one of the least understood interfaces—RS-232C—and one of the first instrument interfaces.

Steve Leibson
Auto-Trol Technology Corporation
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In Part 3 of this series, we looked at the parallel and HPIB or GPIB (IEEE-488) interfaces. This month we turn our attention to the BCD (binary-coded decimal) interface and the RS-232C serial interface. Both of these interfaces are older than those previously covered. The BCD interface traces its origins to scientific instruments that have been in use for decades. The serial interface's roots go back much farther, to the days when buffalo grazed the prairies of North America and André Ampère had an idea for a new method of communication. Let's look first at the BCD interface.

This article is the fourth in Steve Leibson's six-part series, The Input/Output Primer. *The series describes the problems involved in communications between computers and the outside world and explains how some of these problems have been solved. The two remaining articles will discuss character codes and interrupts, buffers, grounds, and signal degradation. "An I/O Glossary," which defines many terms used in these articles, appeared with the first installment (February 1982 BYTE, page 122). Figure and table numbers are continued from Part 3.*

The BCD Interface

The BCD interface has remained popular because it provides a link to older measuring instruments that have been turning out reliable data for years. Some designers still put BCD interfaces in new digital instruments because the BCD interface is simple and inexpensive.

When scientists first connected measuring instruments to computers, existing instruments lacked the electronic sophistication needed to use either the parallel or the IEEE-488 interface. Engineers were faced with developing an interface that relied on the intelligence of the computer to manage communications between the computer and the instruments.

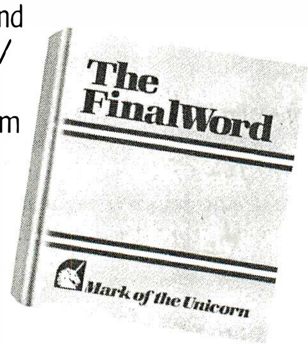
Because measuring instruments send information to the computer but receive no information from it, the new interface could be unidirectional. There might be control lines from the computer to actuate ranges or control other aspects of the instrument's readings, but the control lines did not have to send data.

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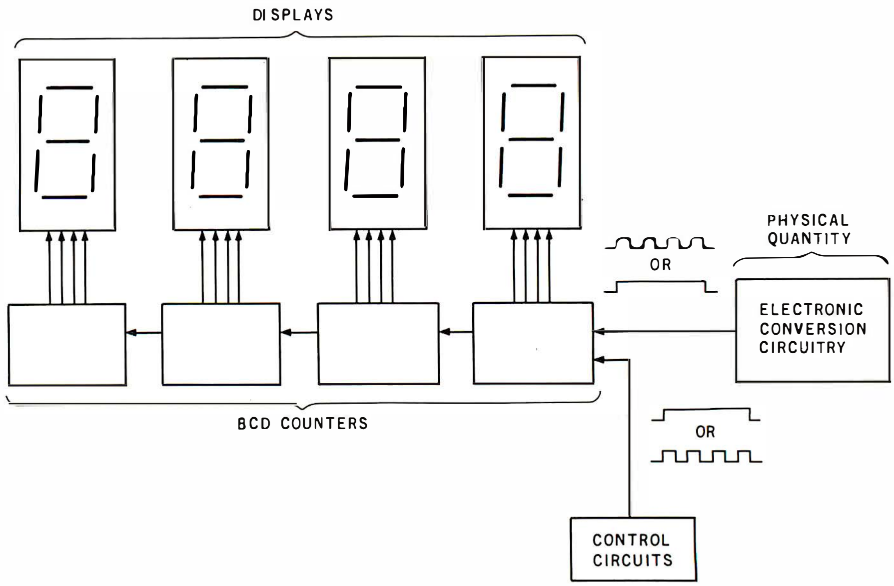


Figure 10: *Block diagram of a BCD instrument. Two signals drive a string of single-digit binary-coded decimal (BCD) counters. One signal is a representation of the physical quantity being measured. This signal may be either a pulse of controlled duration or a series of pulses whose frequency is proportional to the physical quantity being measured. The second signal, from the control circuits, is used for timing.*

ments may have I/O (input/output) connectors with as many as 40 or 50 pins. The new interface had to permit the peripheral instrument to present its entire message at once, sometimes as many as 50 bits in parallel. Then the interface had to break up this wide parallel word into pieces that the computer could digest more easily.

Binary-Coded Decimal Numbers

BCD is a method that expresses each of the 10 decimal numerals (0 through 9) in a binary code. The coding sequence is:

	Binary Code				Decimal
Bit #	3	2	1	0	Numeral
	0	0	0	0	0
	0	0	0	1	1
	0	0	1	0	2
	0	0	1	1	3
	0	1	0	0	4
	0	1	0	1	5
	0	1	1	0	6
	0	1	1	1	7
	1	0	0	0	8
	1	0	0	1	9

Note that 4 binary digits (bits) are required to represent the numerals 8 and 9. Codes 1010 through 1111 are not used. Consequently, BCD coding is not as efficient as pure binary coding, but the ease with which BCD can be displayed for human operators offsets its inefficiency in code compaction.

The standard calendar presents an analogy. Each page contains 5 weeks, more than enough space to hold the days in any month. The extra spaces for days remain blank. That extra space is useless to the printer, but because we *do* block the days of the year into months, the convenience of placing each month on a separate page more than makes up for the wasted space.

Since each decimal digit in BCD coding takes 4 bits, each digit of a scientific-instrument reading requires 4 wires to transmit the binary values that express that digit. Scientific instruments make all digits available simultaneously on the I/O connector, and high-resolution instruments can have connectors with as many as 50 pins. That explains why the BCD interface has to be able to accept such wide data words.

Implementing the BCD Interface

What makes the BCD interfacing technique easy to implement in

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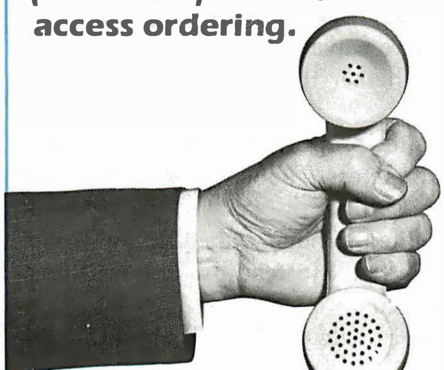
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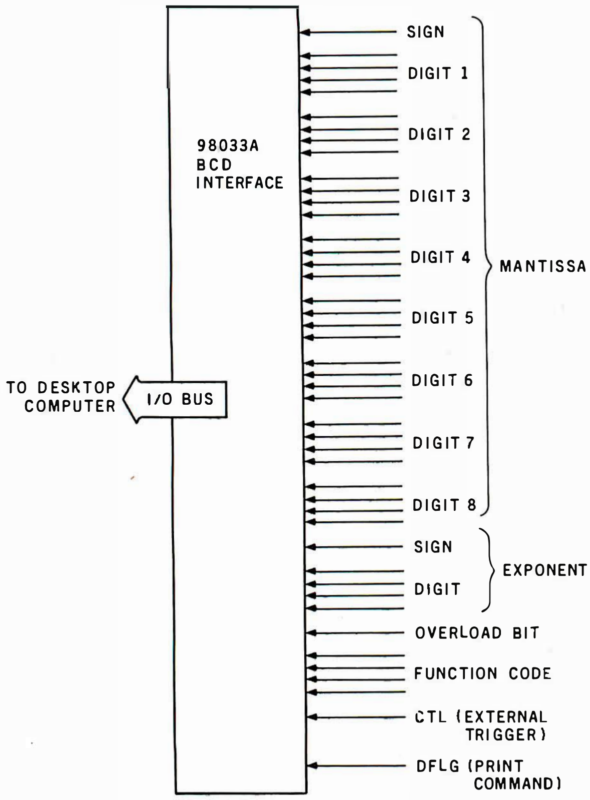


Figure 11: *The 98033A BCD interface. This figure shows how a computer reads in the digits of a BCD instrument. The counters are connected to the BCD interface, which reads in each digit, converts the BCD data to characters, adds delimiting characters, and sends the entire message to the computer. CTL is an external trigger that tells the instrument to take a reading. DFLG (print command) is a signal from the instrument indicating that a valid reading is represented on the digit lines. These two signals, CTL and DFLG, are the handshake lines between the interface and the instrument.*

measuring instruments? The answer lies in the circuitry used to do the measuring.

Figure 10 shows a diagram of a typical measuring instrument. Input to the instrument such as voltage, current, or weight is fed to an electronic circuit that converts the physical parameter to a signal that represents the parameter. This signal may be either of two types: a square wave or a pulse.

A square wave alternately takes on two different fixed values for equal lengths of time. If the signal produced by the instrument is a square wave, the physical quantity measured by the instrument determines the wave's frequency. The frequency is fed to the input of a counter that is allowed to count for a precisely controlled period of time.

If the signal produced by the instrument is a pulse, the physical quantity measured determines the pulse's duration. The pulse is used to control a counter that is clocked by a precise square wave of known frequency.

Whether the signal starts as a frequency or a pulse, the result is a count proportional to the input parameter. The counter drives the digits in a display. If the counter counted in binary, the display would be difficult to read because we think in decimal.

Fortunately, it's possible to use BCD counters in the counter that drives the display. If several BCD counters are placed in series (or *cascaded*), they produce outputs easily displayed in decimal. This works in much the same way as an odometer. Each wheel of the odometer has the numerals 0 through 9 printed on it. Every time a wheel on the odometer makes a full turn, it advances the wheel to the left of it by one count. In a chain of BCD counters, each time a digit advances from 9 to 0, it advances the next higher counter by 1. Each BCD counter has 4 digital output lines that represent the state of the counter. These outputs are used to drive one digit in the display. The digits combine to form the complete reading of the instrument.

This technique is used in a remarkably wide range of digital measuring instruments, including digital clocks. Most instruments use this counting technique to convert a physical quantity into a digital display; in the case of digital clocks, of course, the quantities are periods of time.

The BCD Interface Is Born

The first accessory that designers added to their digital instruments was a printer, which made it possible for an unattended instrument to log its own readings. Signal lines were brought out of the instruments to drive the print wheels—one print wheel for each digit. These signal lines were nothing more than the digital output lines of the BCD counters in the instrument. The counters drove the display and positioned the print wheel just before it struck the paper.

By supplementing the counter output lines with just two more signals, designers created the BCD interface. One of the added signals told the printer when the reading was valid (*print command*), and the other allowed the printer to pace the readings (*external trigger*) so that the instrument would not take readings faster than the printer could print them. These two signals form the handshake mechanism of the BCD interface.

At its birth BCD interfacing was a big success. Experiments that had required an attendant to write down readings (usually some unlucky graduate student or technician) could now be automated. Printed logs could be obtained for production testing. The tedious job of recording data was greatly simplified. If a printer could do all that, just think what could be done by substituting a computer for the printer! The system would not only log information but also analyze it, process it, and take

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	MANTISSA										EXPONENT					

X = BCD DIGIT Ov = OVERLOAD BIT CHARACTER 15 = FUNCTION CODE

Figure 12: *The BCD message format is a floating-point number in scientific notation followed by a comma, an overflow character, a function code, and a linefeed terminator. The floating-point number is represented by a sign, a mantissa, an "E" which indicates that an exponent follows, an exponent sign, and an exponent. Unused BCD digit inputs may be grounded; they will then be transmitted to the computer as 0s.*

appropriate action. The eyes and ears of a computerized process control loop were about to come into being.

A Real BCD Interface

Let's look at an actual BCD interface. My example will be the Hewlett-Packard 98033A BCD interface designed for the 9800 series of desktop computers (see figure 11).

The 98033A has several inputs that connect to the BCD instrument. Enough signal wires are included for an 8-digit mantissa with a sign bit and a 1-digit exponent, also with a sign bit. If this terminology is unfamiliar, think of a number, say, 1,427,327. That is how *you* might write it. In scientific notation, that number is:

$$1.427327 \times 10^6$$

The 1.427327 is called the mantissa and represents the *significant figures* of the number. The 6 is the exponent and represents the power of 10 by which the mantissa is multiplied to get the value of the number.

In addition to the mantissa and exponent inputs, the 98033A has an overload input bit and inputs for a 4-bit function code. Unlike the odometer, most instruments don't roll the display back to 0 when a counter reaches maximum count plus 1. Instead, they indicate an overflow, informing the operator that the input is too big to measure. The function-code bits are useful for instruments that can measure more than one range or quantity.

When the computer takes a reading, the interface scans each digit and converts the BCD values into ASCII characters. The ASCII characters are sent to the computer serially. A reading is composed of 16 characters. As shown in figure 12, 8 digits are available for the mantissa and 1 for the exponent; this format is usually sufficient to interface a BCD instrument. If the instrument has fewer digits to send, unused inputs may be grounded to read 0s.

Interfacing Flexibility

Because no standard for BCD interfacing yet exists, the 98033A offers flexibility in the interpretation of signal wires. It can be configured to either positive- or negative-true signal levels. Input-signal voltages are constrained to be TTL-compatible, meaning that the low level is between 0 and 0.7 volts (V) and the high level is between 2 and 5.5 V. This signal level comes from the TTL logic circuit family, which has dominated digital designs since the late 1960s.

The tenth, thirteenth, and sixteenth characters of the ASCII string of characters sent by the interface are generated within the interface itself. They aid the computer in deciphering the meaning of the digits coming from the instrument. Character 10 is always an "E," which is shorthand for *exponent*. The "E" separates the mantissa from the exponent. The thirteenth character is a comma and separates the exponent from the function code. The sixteenth and last character, the linefeed or <LF>, is a message terminator, informing the computer that transmission of the reading is complete.

Intelligence in the 98033A replaces any that might otherwise have to reside in the instrument. The 98033A provides a data path between today's computers and earlier interfacing instruments. Furthermore, the 98033A eases the burden for today's designers who cannot justify the development and manufacturing costs required to include a more complex interface in a new instrument.

The Unstandard Interface: Serial I/O

The first electronic digital computers appeared in the 1940s, and serious work in computer data com-



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munications didn't start until the next decade. When engineers began to connect computers to other devices, they drew upon serial I/O, a technology that had originated in the previous century.

The first electrical device used extensively for communications was the telegraph. Samuel Morse learned of André Ampère's idea for the telegraph in 1832. Morse improved the telegraph mechanically, but more important, he devised the Morse code. This was the first really practical encoding of human communications symbols into a form that is machine-transmittable.

Symbols are represented in Morse code by a series of dots and dashes, with each character having its own unique representation. The dots and dashes may be considered the predecessors of the 1s and 0s of the character codes we use in computer data communications today.

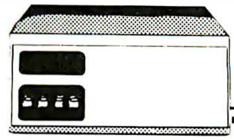
Improvements in the telegraph led to printing telegraphs that required no human operator to decipher the codes. New codes and more advanced machines evolved, culminating with the teletypewriter. By the time the teletypewriter was introduced, dots and dashes had become 1s and 0s. The Morse code gave way to codes that assigned the same number of bits to each character, making messages much easier for a machine to decode.

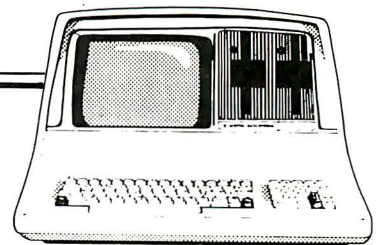
By the time the electronic computer came into being, a wealth of technology already existed for electronic data communications. Teletypewriters served as I/O devices between people and computers. The keyboard and printer of the teletypewriter provided a low-cost data entry and display mechanism. As technology progressed, cathode-ray tube terminals and faster printers replaced the teletypewriter, but the serial interfacing remained.

Transmitting Over One Wire

The basis for serial data communications is the transmission of information over one wire. The interfacing techniques previously discussed all rely on several parallel wires to carry information between

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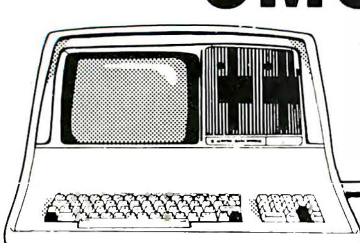
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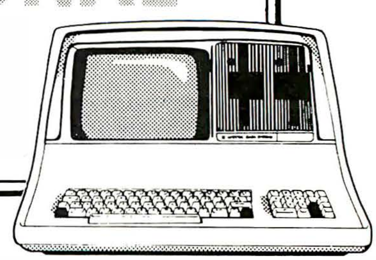
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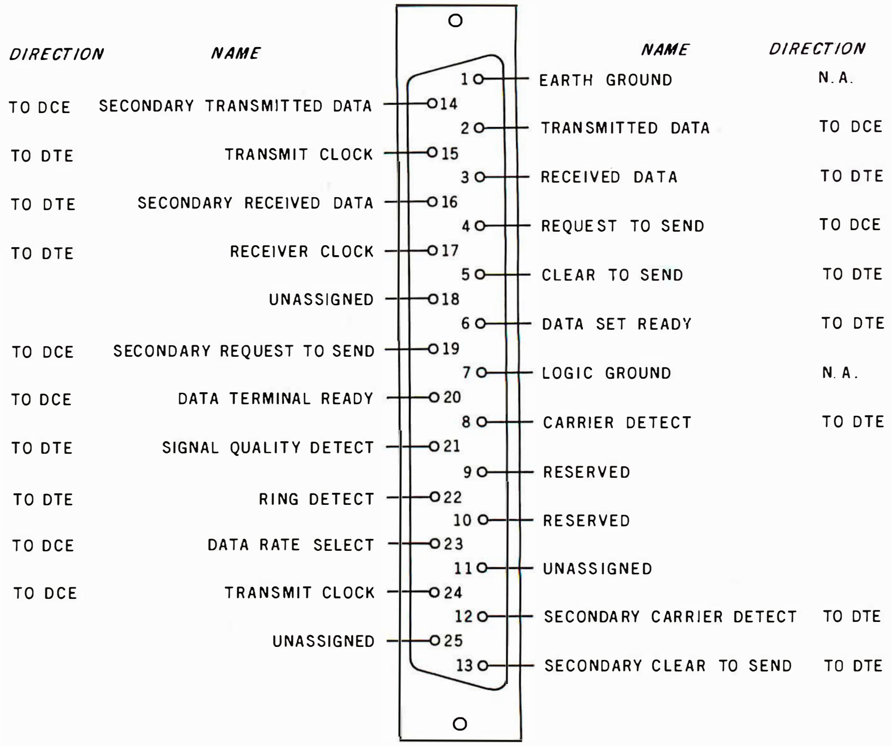


Figure 13: *The RS-232 connector. The most abused connector in interfacing, this 25-pin subminiature D connector is used by most manufacturers for RS-232C interfacing. The terminal is supposed to use the male version of the connector, and the modem is to use the female version. Some devices use only pins 2, 3, and 7, while other devices use more pins. The reserved and unassigned pins have been used for anything from handshake signals to current-loop signal pins to power-supply pins. The RS-232C standard endorses none of these uses. The "Basic 8" pins are 1 through 7 and 20. If you manage to get these 8 pins connected correctly, the interface will probably work. Beware the phrase "standard RS-232C." The only standard is that advertising phrase.*

devices; each wire carries a single bit of a character that is composed of multiple bits. When long distances separate a computer and its peripheral, the cost of running several wires in parallel becomes prohibitive. Serial interfacing provides a much less expensive solution.

Computer timesharing was born when computers became sufficiently powerful to handle several tasks simultaneously. Because computers were still very expensive, it was desirable to spread their cost over many users. But how were users at several locations to be connected to the central computing facility? Stringing wires to each location was too costly. Fortunately, the telephone system already had a suitable network of communications links.

However, these links were not limited to wires. Satellite and land-based microwave links also made up part of the phone system. Furthermore, all of these links were designed to carry voice, not computer data, and the phone companies winced at the prospect of finding all kinds of strange signals in their networks. Because teletypewriters did not have standardized interfacing requirements, the voltages involved could range from 6 to 140 V. A standard was required.

The RS-232C Standard

The Electronic Industries Association (EIA) standard RS-232C was specifically designed to do one thing: to define the electrical characteristics for an interface between a piece of data terminal equipment (DTE) and a piece of data communications equipment (DCE). The DTE is the terminal for the timeshare user, while the DCE is a modulator-demodulator (modem) that encodes computer data into voice-like signals that are permissible on the phone system.

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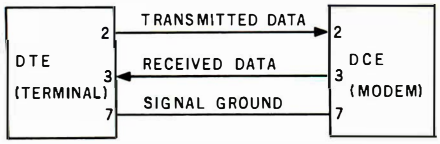


Figure 14: *A minimal RS-232C link. A minimum of three wires is required to connect two RS-232C-compatible devices for bidirectional communication. Note that the DTE (data terminal equipment) transmits on pin 2 (transmitted data) and receives on pin 3 (received data). The DCE (data communications equipment) transmits on pin 3 and receives on pin 2. The signal names are from the DTE's perspective. Two DTEs or DCEs may communicate by cross-wiring pins 2 and 3. Some people think that is the normal way of connecting RS-232C devices, which shows how "standard" the standard is. Pin 7, the signal ground, is a return path for the signal current, and pin 1 is the earth ground. It's usually a good idea to connect the earth grounds between devices.*

Figure 13 depicts the connector used with the RS-232C standard. Note that more than one wire is involved at this interface. Pins 2 and 3, the data-carrying wires, are called *transmitted* and *received data.* Pin 7 is a signal ground and serves as a current return path between the DCE and the DTE. These three wires are sufficient for bidirectional communications between the DCE and the DTE.

What are the other wires for, then? They serve as control wires between the DCE and the DTE and are there to establish and maintain a communication link with the computer. Let's ignore those other wires for now and examine the data lines more closely.

Common sense would tell you that the RS-232C standard allows data to be sent out on the transmitted-data line and received on the received-data line. Right? Wrong! Which device transmits on the transmitted data line, the DTE or the DCE? Both cannot transmit on pin 2 and receive on pin 3. If the DTE transmits on a wire, the DCE must have a receiver on that same wire, or there is no communication.

Note the difference between serial I/O and IEEE-488 (HPIB). The IEEE-488 standard specifies bidirectional data lines. RS-232C was developed earlier, and bidirectionality wasn't possible with the technology of the day. With just two data lines, it wasn't required either.

Which piece of equipment *does* transmit on the transmitted-data line? *All signal names in the RS-232C standard are from the perspective of the DTE.* Thus, the DTE transmits on pin 2 and receives on pin 3. The DCE transmits on pin 3 and receives on pin 2. Figure 14 should clear up any confusion about this.

Now to become confused again. Suppose you're going to connect a computer to a printer through the "standard RS-232C" port. Which device is a DTE, and which is a DCE? More specifically, which is going to transmit on pin 2 of the RS-232C connector, and which will transmit on pin 3? Neither the computer nor the printer is a terminal or a modem.

Manufacturers of these devices may offer cables which allow their equipment to look like either a DTE or a DCE. More often, however, the RS-232C connector is bolted to the back of the device, and no choice is possible. The manufacturer has had to make an arbitrary decision, one that will be wrong 50 percent of the time.

In the case of two devices of the same type, DTE or DCE, a *haywire* cable will have to be assembled to get signals onto the correct wires. Usually, this task falls to the user.

We have just jumped the first hurdle in connecting RS-232C equipment: physical plug-to-plug incompatibility. Many more potential problems are related to the data signal itself.

First, signal levels differ from those of the other interfaces discussed. RS-232C does not use TTL signals because TTL didn't exist when the standard was written. A positive voltage between 5 and 25 V is used to represent a logic 0 level on the RS-232C data lines. A negative voltage between −5 and −25 V represents a logic 1 level.

These levels are true only for the data lines on pins 2 and 3; they are negative-true. All other signals in RS-232C are positive-true; therefore, a positive voltage represents a logic 1, and a negative voltage represents a logic 0. The same voltage levels are used; they just represent different logic levels.

Because the bits of a character are separated by time, a waveform is produced on the data line when a character is transmitted. Such a waveform for the transmission of the ASCII character "E" is shown in figure 15. The ASCII code for "E" is 1000101 in binary, and its least significant bit is transmitted first. The data line idles in the logic 1 state, and the waveform of figure 15 is read from left to right.

Waiting for Start

For asynchronous serial data communications, a start bit is always sent first to mark the beginning of the character. (Synchronous data communications is different and won't be discussed here.) Following the start bit are the data bits in the character, sent in order from least to most significant. Each bit is held on the data line for a precisely controlled length of time called a *bit time.*

The receiver, which is alerted to the incoming character by the start bit, times the incoming signal and samples each bit as near to the center of each bit time as possible. Naturally, the transmitter and the receiver must agree on the length of time a bit will be held on the data line or the transmission will be garbled by samples made at incorrect times.

Bit time determines the maximum rate at which characters may be transmitted and thus defines the *bit rate* at which the RS-232C interface runs. Standard bit rates are 50, 75, 110, 134.5, 150, 300, 600, 1200, 2400, 3600, 4800, and 9600 bits per second (bps).

Parity and Stop Bits

Following the data bits may be a *parity bit,* which is used for error

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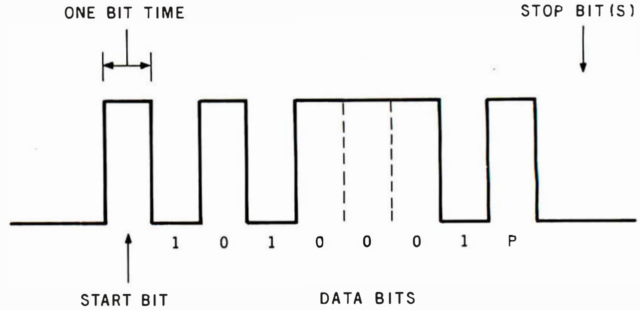


Figure 15: *The serial waveform. Serial information uses time to separate the bits of a message. This figure shows a 7-bit character being transmitted serially. A start bit goes first to signal the receiver that a character is coming. The start bit is always a 0 and is followed by the 7 data bits, transmitted from the least significant to most significant bit. The character shown being sent is 1000101, which is the ASCII code for "E". The data bits are followed by an optional parity bit for error checking, then 1 or 2 stop bits which are always 0. The stop bits serve to separate the characters and to give the receiver time to finish assembling a character before the next one starts coming in.*

detection. A noise pulse could affect the data line at the wrong time, causing a bit in the transmission to be misread. If the transmitter keeps track of the number of 1s in the character being transmitted, it can set the parity bit so that the total number of 1s is always even (for even parity) or odd (for odd parity). The receiver can also keep track of and use the parity bit to determine whether the transmission was received in error. Parity is useful for detecting single-bit errors. If more bits are affected, parity might not detect the error.

The last bits to be transmitted are the *stop bits*. These are not really bits but stop times to allow the receiver time to assemble the serial bits just received, send the assembled character on, and prepare for the next character. There may be 1, 1.5, or 2 bit times allowed for stop bits. Since this is a rest period, "fractional bits" are allowed.

Picking Up the Pieces

Now, given the format of the data transmission, what could possibly go wrong? First, the transmitter and receiver must agree on several parameters. The bit rate has been mentioned already. In addition, the parity (odd, even, or none) and the number of stop bits must be set the same in both transmitter and receiver.

Character codes must also be considered (more on these next month). Our example uses the ASCII character set with 7 bits per character. ASCII is the most popular code in use today, but 5-bit codes (Baudot and Murray), 6-bit codes (IBM Correspondence Code), and 8-bit codes (IBM EBCDIC) also exist. The RS-232C standard does not restrict the number of bits per character.

After connecting the computer and printer so that they use the proper wires and agree on bit rate, parity, number of stop bits, and character code, you may feel that this interface is licked. Not so.

Suppose the printer is set up for ASCII 7-bit characters, odd parity, and 1 stop bit. In addition, the bit rate is set to 9600 bps. Well, that's fine. I've set the bit rate to the fastest rate so that the equipment doesn't waste a lot of time sending characters and the printer will be used at its maximum speed. Assume that the computer side of the interface has been set compatibly.

Now I'll write a program on the computer to send one line of text to the printer to be printed, being careful to put lots of comments in the program so I can remember what I did. The program works! I then list the program on the printer to have a record of my triumph. Unfortunately, several characters seem to have been lost in the transmission. I try again with equally dismal results. Running the program meets again

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with success and listing again fails. What is going on?

No Handshake Today

First, let's consider the data rate at which the computer is sending characters. ASCII uses 7 bits plus 1 for the parity bit, 1 for the stop bit, and a start bit, for a total of 10 bits per character. The computer is sending 9600 bits per second, which is equivalent to 960 characters per second.

A quick look at the printer specifications reveals the problem. The printer can print a maximum of only 175 characters per second. We are sending data to the printer five times faster than it can print! Most printers have buffers and can tolerate this mismatched data rate until the buffer fills. After that, any subsequent characters transmitted will fall on the floor! Running my program required transmitting less than a buffer full of characters. Because the buffer didn't overflow, there was no problem. Listing the program on the printer, however, required sending more characters. When the buffer overflowed, characters were lost.

The success of a handshake mechanism in an RS-232C interface cannot be predicted without studying manuals for both of the devices involved.

Other interfaces have handshake mechanisms to prevent data transmitters from going too fast for their receivers. Surely, RS-232C also has a handshake mechanism to prevent this problem? Nope. Returning to figure 13, let's now consider the other RS-232C signals and try to find some to use as a handshake mechanism. Look in particular for two sets of handshake lines: one for the transmitted-data line and the other for the receive-data line.

Aha! Pins 4 and 5 are called *Request to Send* and *Clear to Send*. These certainly look like prime contenders for handshake lines. Unfortunately, many printer manufacturers have also fallen into this trap. The names of the signals on pins 4 and 5 do indeed lead you to believe that they form a data-handshake mechanism. According to the strict RS-232C definition, the DTE asserts Request to Send when it has data to transmit. It then waits for the DCE to assert Clear to Send before transmitting. That's half of the traditional handshake. The problem is that the DCE is not allowed to drop Clear to Send until the DTE drops Request to Send.

Take a Long Drink

This situation is similar to taking a drink from a garden hose with a friend controlling the spigot. It's easy to start the flow, but you'd better be prepared to take either a long drink or a short shower.

The DTE and DCE signals on pins 4 and 5 were intended as a handshake between the terminal and the modem (remember those?) to allow the terminal to request control of the communications link from the modem. They also make it possible for the modem to tell the terminal when the link has been acquired. The terminal is then allowed to assume that it will keep the link as long as it wishes. Thus, the DCE cannot arbitrarily drop Clear to Send whenever it wishes.

Request to Send and Clear to Send are indeed handshake lines. Unfortunately, the DTE and the communications link are handshaking, not the DTE and the DCE. Also, this handshake is on a message basis, not character by character. Use of pins 4 and 5 of the RS-232C connector can result in success but usually results in a spectacular failure.

Some manufacturers have ignored the strict definition of pins 4 and 5 and use them for a data handshake anyway. Others avoid the conflict by using the Data Terminal Ready or Data Set Ready lines (depending on whether they are emulating a terminal or a modem). None of these lines was intended to be used for data handshaking. Use of any RS-232C line for handshaking does not

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guarantee recognition of the handshake by the device at the other end of the cable.

Consider other possibilities of using Clear to Send as a handshake line. If a device drops Clear to Send in the middle of a character transmission, what does that mean? If the transmitter stops immediately, in the middle of the character, that character is sure to be garbled because timing is important in serial communications. If the transmitter waits until that character transmission is complete and then stops, there may be no room in the receiver's buffer for that last character transmitted.

Because this possibility is not considered in the standard, the success of a handshake mechanism in an RS-232C interface cannot be predicted without studying manuals for both of the devices involved. Sometimes even studying the manuals doesn't help.

Back to the Beginning

Finally, consider the device that started this discussion, the teletypewriter. The RS-232C standard at least defines a connector pinout and signal levels. No such standards exist for teletypewriters. The serial transmission format is the same, with start and stop bits, data bits, and parity bits.

The RS-232C standard defines the electrical characteristics for an interface between a piece of data terminal equipment (DTE) and a piece of data communications equipment (DCE).

The signal interface uses a technique called *current loop*. Instead of positive and negative voltages representing logic 1s and 0s, current loop uses presence or absence of current. Presence may be either 20 or 60 milliamperes, depending on the teletypewriter model. No standard connector or standard pinouts exist for current-loop operation.

Despite all these problems, designers of serial interfaces for computers strive to include current-loop capabilities in their interface designs. Where RS-232C is limited to a 50-foot cable (an often-violated part of the standard), current loop can be run much farther. In addition, the current-loop interface has been around for a long time, and several devices other than teletypewriters use this interface. Finally, teletypewriters remain a cost-effective solution as a combination printer and terminal.

Handle with Care

As you can see, serial interfacing needs to be approached more carefully than other hardware interfacing techniques. The "standard RS-232C" nomenclature persists in specification sheets even though most uses of the interface are far from standard.

As technology progresses, serial interfaces become more adept at covering an ever-widening range of hardware. Unfortunately, this still doesn't guarantee an efficient interface in every application because serial I/O remains the unstandard interface.

I've now discussed the four basic interfaces: parallel, IEEE-488, BCD, and serial. Without these interfaces, the computer systems we all know and love wouldn't be able to do much useful work.

Next month I'll examine the character codes used for data transmission. Character codes are another major source of incompatibility in computer communications. I'll discuss the problems presented by different character codes and how today's software strives to cope with incompatibilities. ■

Steve Leibson has written a booklet called "Computer Input/Output Course," published by Instruments & Control Systems, Chilton Way, Radnor, PA 19089. Price of the book is $9.95


Getting rave reviews from the boss may be the best reason to switch to Opus.

Alien Typhoon

Walt Latocha
5328 South Narragansett
Chicago, IL 60638

In the history of arcade games, Space Invaders has been an enduring favorite, as the number and popularity of its descendants will attest. The Bally Company's coin-operated version of Space Invaders was a fantastic success, and when the initial popularity of the game started to fade, the company introduced an improved version, Deluxe Space Invaders. Later, Bally improved upon the basic motif once again to produce Galaxian—the most difficult variation on the Space Invaders theme.

Galaxian's popularity was somewhat eclipsed by the Asteroids craze; nevertheless, Galaxian, like other popular arcade games, was favored enough to be copied for the home-computer market.

One of the first of the Galaxian clones was Broderbund Software's Alien Rain. After great success with that game, Broderbund has issued a more challenging version named, appropriately, Alien Typhoon.

In Alien Typhoon, as in Space Invaders, you control a gun that appears on the bottom of the screen. You can move the gun and fire it either by keyboard input or by a paddle controller. Above the gun hangs a constantly moving swarm of up to forty-six alien spacecraft.

Alien Typhoon differs from Space Invaders in that the aliens don't march down the screen in orderly ranks; rather, the ships peel off from the main cloud and dive-bomb your gun in groups of one to ten ships at a time.

As in Space Invaders, the aliens can attack and destroy your gun with gunfire of their own, but you face an added hazard when a spacecraft uses a ramming maneuver to demolish your gun. You have only two defense options—shoot the alien craft or get out of its way when it comes swooping down.

You are initially allowed three guns per game. If you earn a total of 5000 points (scored by destroying the alien ships that, depending on their types, have various point values) you are awarded a fourth weapon.

Documentation for the game is nonexistent (the only thing that comes close is a warning on the disk's package that reads, "For Fanatics Only!! Twice as many, twice as fast, and twice as tricky!"). However, the lack of documentation doesn't handicap this easily understood game.

But there is absolutely nothing lacking in the game's graphics, which take full advantage of the Apple's resources. Beautiful color increases the excitement as the enemy craft swoop, bank, loop, and curl across the screen. In fact, the graphics are one of the major tactics that the computer uses in the game. Often a player will find himself bedazzled by the wild gyrations of one particular alien craft while another beelines in on a suicide run. The graphics alone make Alien Typhoon worth buying, and the game's sound effects are adequate and give proper emphasis to the mayhem on the screen.

As far as difficulty is concerned, I recommend that you take heed of the warning on the package. This game offers plenty of challenge—perhaps too much for some players. As a rule of thumb, if you haven't mastered Space Invaders or an equivalent game, think twice about purchasing Alien Typhoon.

Conclusion

Alien Typhoon is a fast-action, sophisticated, arcade-type game with exceptional color graphics. The game requires great skill (more, in fact, than Galaxian, the original coin-operated game on which it is based), but if you have the required aptitude, the game should hold your interest for hours. ■

At a Glance

Name
Alien Typhoon

Type
Arcade-style game

Manufacturer
Broderbund Software Inc.
1938 Fourth St.
San Rafael, CA 94901
(415) 456-6424

Price
$24.95

Author
Tony Suzuki

Format
5¼-inch floppy disk

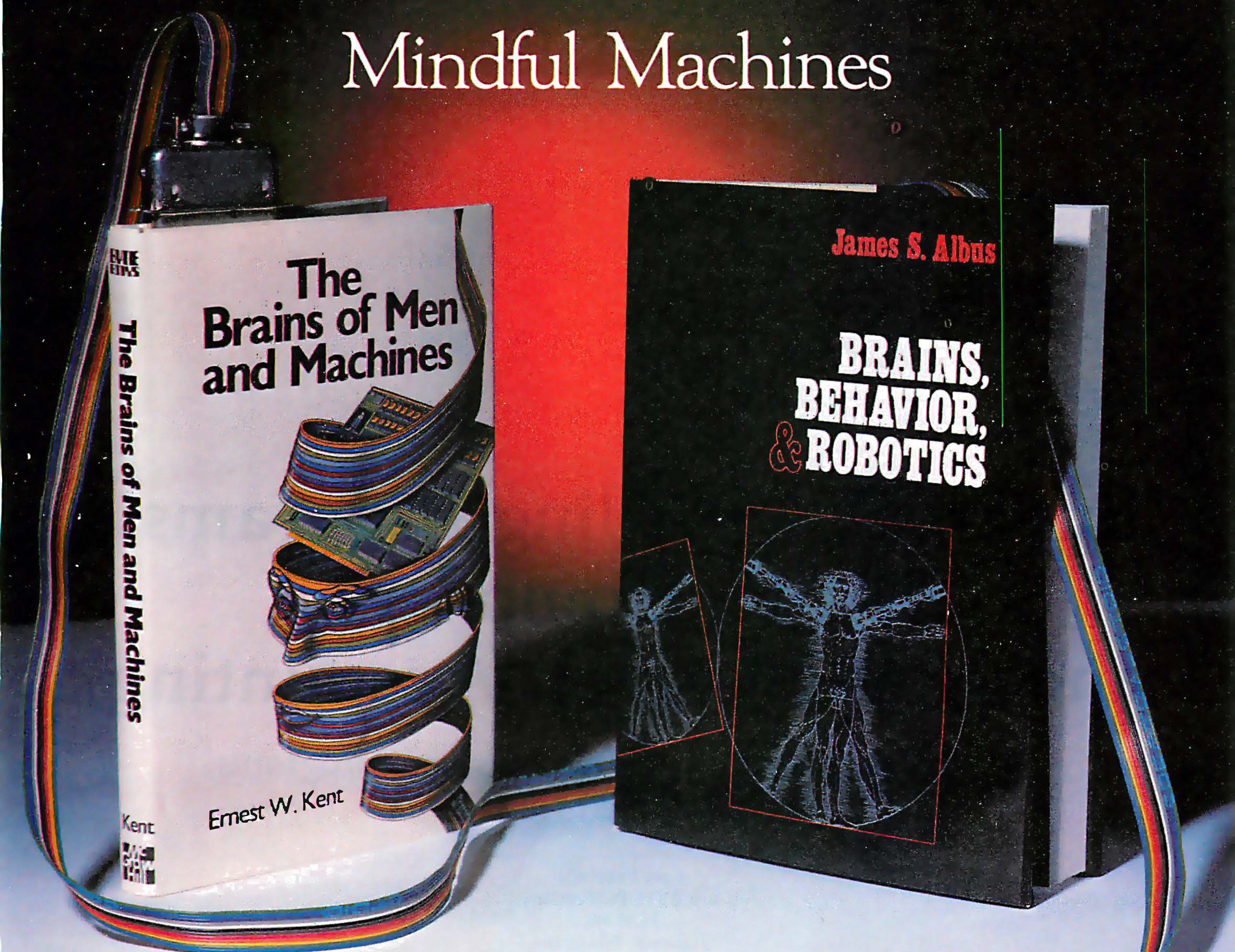
Language
6502 machine language

Computer
Apple II or Apple II Plus with one disk and 48K bytes of memory

Documentation
None

Audience
Experienced game players

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"There may not be a lot of *really new* software," I said to my mad friend, "but there's a lot of good stuff coming out."

"What do you have in mind?" he asked.

"Well, there's Sorcim's Supercalc. I really like that one. Whatever you'd like to do with scratch-pad math, it'll do it, and simply. I've got two different versions, one on 5¼-inch disks for the Osborne 1 and another on 8-inch disks for the Godbout. And I love them both."

Which I do. One of the nicest things about Supercalc is the documentation, although it looks a bit formidable when you first open it (there are a lot of pages there). But on inspection it really tells you a lot about how to use the program. Neither I nor my assistants had any difficulty learning to use the program because there is not only complete program documentation, but also good Help instructions.

CB80 has all the advantages and disadvantages of CBASIC-2.

"But there's no index," my mad friend said. "Mark 'em down. Tell the world. Dammit, there's no excuse for software without indexed documents."

A sentiment I thoroughly share, but Sorcim has an excuse for this one. Supercalc is so darned easy to use, once you get the hang of it, that the on-line Help files, plus the handy-dandy little "AnswerCard" that comes with it, are all you really need; most of the documentation is a tutorial, not a reference guide. Me, I think I'd have designed the documents slightly differently, with an indexed reference work appended to the tutorial; but that's a mild preference. Certainly you can learn Supercalc from what Sorcim supplies.

It's worth learning, too. Like dBase II, Spellguard, and WRITE, Supercalc is destined to become a classic, a program that does what it says it will do with very little fuss and bother.

What Supercalc does is calculate. It is, of course, a Visicalc "work-alike," designed to work on 8080/Z80 CP/M systems. Imagine a big work sheet spread out in rows and columns of

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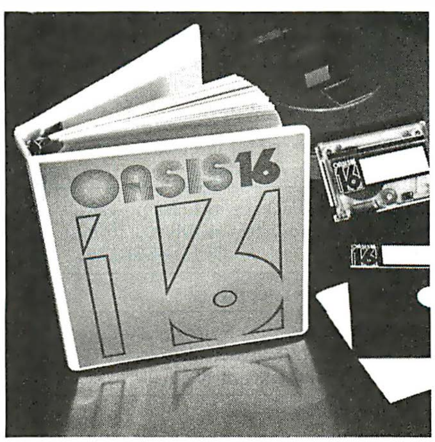
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cells. Now imagine that into any cell you can enter any darned thing you want: a number, a label such as "sales tax" or "horsefeathers," or perhaps a formula such as "the sum of the five cells above this one." Another formula might be "the average of all the cells in the next row" or "the square of the cell above divided by pi." Finally, imagine that as soon as you enter a number that affects any cells in which you have formulas, the values, no matter how complex, are instantly recalculated and displayed.

That's Supercalc. Not only does it do all the above, but there are really nifty edit features that make it easy to get at the cells you want to work on; and you can save your work in a disk file at any time. I imagine the IRS is going to just hate Supercalc and all the programs like it; it will now be relatively easy to calculate your taxes in every conceivable way and choose the one you like best. The nicest part about it, too, is that if you use your computer to do your taxes, it's likely to be deductible—certainly the software is.

Sorcim is a thoroughly professional software company that also supplies the basic input/output system (BIOS) for the Godbout 8085 computer; and therein lies an instructive tale.

Supercalc has an installation program that lets you tell it what terminal you're using. Supercalc likes a half dozen or so terminals and will tolerate a few more. One that it likes is the Zenith Z-19, which is good because that's what I've connected to my new Godbout 8085/88. The Z-19 has a standard 24 lines of 80 columns, plus a special 25th status line that can't be got at without special programming. Supercalc uses the special programming to give some helpful information.

The Z-19 also has a row of special-feature buttons that send an escape sequence—that is, the character "escape" (1B hexadecimal) and then a number or letter. Supercalc catches these and uses them to do nifty things like controlling the cursor and displaying Help files.

Unfortunately, the package I received from Sorcim didn't quite do that. There appeared on the 25th line a message that the "red square" special-purpose button was the "Help" button and that the "blue square" button would toggle the special shift to turn the numeric keypad into cursor controls; but in fact neither the red nor the blue button did anything at all, and trying to use the shift feature on the numeric keypad produced weird results that nothing seemed able to fix.

So now what? I sent a note to Richard Frank, president of Sorcim, and a few days later got a phone call from one of Sorcim's engineers. Other Z-19 terminals worked with Supercalc, so it wasn't the program. A few tests carried out during the phone conversation produced even stranger results: the terminal was operating well, but the computer wasn't receiving the escape sequences

the terminal was generating. Just what was going on?

Eventually we found it. The Godbout BIOS for the 8085 expects one pattern of data and stop bits; the Z-19 sends another. To make it worse, the Z-19, although an excellent terminal in many ways—I recommend it as about as good as you can get just now—has some minor bugs in its program chips, and those bugs interact with the Sorcim-supplied 8085 BIOS and Supercalc to generate the strange results I noticed.

If all this seems confusing to you, imagine what *I* thought about it while it was happening to me! Eventually, though, I got my friend and computer consultant Tony Pietsch together with the Sorcim program specialists, and all was fixed nicely. Moreover, Sorcim is putting the problem and its solution into its Supercalc manual and notifying Godbout. The moral of this story is that if you insist on a state-of-the-art system (such as the Godbout 8085/88), you'd better be prepared for some unexpected results; but if you deal with reputable companies, you'll eventually get satisfaction.

Microproof and Spellstar

Then there are the smaller companies: they want to do right, but they have limited resources. A lot of really good software comes out of such companies, but there are some problems too.

Example: As a result of my last column, Cornucopia Software has sent me four separate iterations of fixes for Microproof. Each version had problems, and each time I sent Cornucopia notes on what it probably ought to do. Lo! Cornucopia has now managed to take care of nearly all my objections to the program. It has speeded Microproof up enormously, overhauled the error-trapping procedures, made it easier to use, and generally fixed things up. But Microproof still doesn't handle dashes very well—the program thinks, for example, that "well—the" as I used it here is a candidate misspelled word. Quotation marks give Microproof problems too. There's another difficulty: with Microproof you can correct the word by spelling it properly, after which the program will go through your text file and globally make the changes. What, though, do you do about capitalization? (Mostly you hope you haven't begun any sentences with the word.)

Anyway, it took several iterations, but eventually Cornucopia developed a useful spelling program. A number of other companies have read my preliminary reviews of other programs and proceeded to patch things up and send me frantic revisions.

"So. You're a quality control department," my mad friend said.

"Well, not for everyone. And sometimes it's a fairly complicated situation like the problems with Supercalc and the Z-19 terminal."

"Yeah, sure," my mad friend said. "But did you ever stop to think how many software houses routinely use

their *paying customers* as their quality control department? Look—how much advance-notice software do you get?"

I thought about it. "Not too much. Mostly I get advertised stuff because I write and ask for it. Sometimes an outfit will see a review and ask if I want to see its new product. I try to be fair, but I don't have time to help with development."

"But you do anyway. Now think about the poor guy who buys new software that doesn't quite work. He doesn't know what to do. The license agreements discourage sending anything back for refunds. He doesn't even know how to describe the problem, or maybe he hasn't enough experience with competing programs to know he has a lemon. And meanwhile the publishers keep those $500 price tags—and complain about pirates."

Unfortunately, my mad friend is right. In fact, things are worse than that. Some companies, like Cornucopia, *try* to fix things when their customers complain and eventually do things right. Others just ignore the complaints and take the money and run.

And yet. It's certainly to our (the users') advantage that a lot of small software houses spring up. We don't want the field dominated by a few giants with ever-more-restrictive licensing policies ("Levitical documentation," as my mad friend calls it). We want a lot of competition, which means, I guess, that those of us who like to try new products just better get used to being unpaid quality control departments. Sigh.

I have another spelling program, Spellstar. It's pretty nifty. It's a bit slow, compared to Spellguard, but it does have some nice features. For example, Spellstar lets you mark the words you're interested in, then shows you the document with those words highlighted; on my Z-19, they're in reverse video. So, there they are, completely in context and marked so I can't miss them. Very nice.

Even better, if you tell Spellstar to ignore a word in the future, it'll do that: from then on, when it hits the marked word, it will unmark it and go right past it. When you drop out of Spellstar you're in Wordstar, so that you can use a global search and replacement to fix every future instance of the mistake.

Indeed, if I used Wordstar as an editor, I'd be tempted to use Spellstar in connection with it. However, I do have to warn you that a couple of my knowledgeable friends who do use Wordstar and who have Spellstar available to them prefer to use Spellguard on the grounds that it is just overall more convenient, especially for longer documents.

Languages, Mon Amour

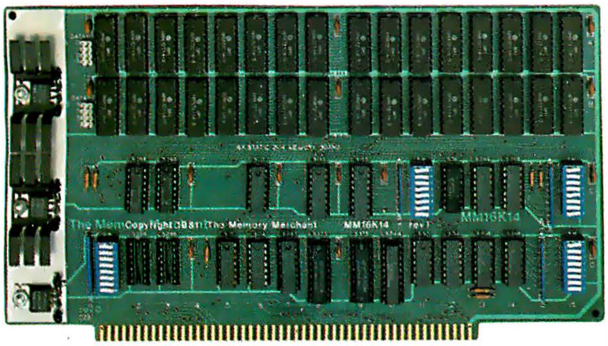
I know of two new BASIC compilers, and they're both excellent. It's almost an *embarras de richesse*. In my last review, I described the new features of Microsoft's BASCOM BASIC Compiler. I mentioned that Microsoft has added CHAIN and COMMON and that now only one run-time package is necessary.

One major consequence of only requiring one copy of the run-time program to be present on the disk (even though you may have half a dozen compiled programs) is that the compiled programs are shorter. Not all *that* much shorter, if you count program and run-time package; but the instant you have several compiled programs present, the disk savings mount. (I chuckle at that now; with my new Qume double-sided double-density disk system, I have more than 2 megabytes of floppy storage available, which means I don't worry so much about disk space. Yet. . . .)

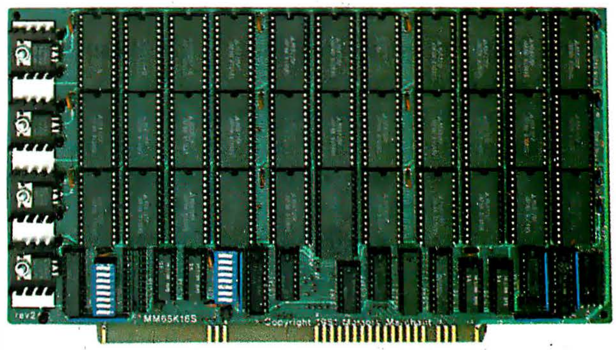
Of course, if you use the run-time package, you're liable for the new royalty payments on any software you sell. (Microsoft dropped the royalty requirement for programs compiled with the old BASCOM, as I discussed in my last column.) You could, I guess, sell programs written

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in Microsoft BASIC and compilable with BASCOM, leaving it to the customer to buy his own copy of BASCOM with a run-time package.

And, of course, you can use BASCOM to develop as many programs as you like for yourself. Since BASCOM is *almost* the same language as Microsoft's BASIC-80 interpreter, the result is a very powerful tool: you can run programs interpretively, squeezing out the syntax errors, then test the program logic, all while having an instant editor available for fix-up. Now, true, it would be a *lot* easier if BASIC-80 didn't simply dump your program and scrub all its variables whenever you make any program change whatever (even to add a remark!); but you can't have everything. (I wish we could, though; and if Microsoft wants to update BASIC-80, I *strongly* suggest that improvement.)

A second major defect of BASCOM is its surprising inability to deal with arrays. The rule with BASCOM is, once dimensioned, always dimensioned. You cannot change dimensions at all. Worse, you can't compute the size of a dimension, even if the compiler has been told everything it would need for the calculation. You can't even use a variable for dimension size. The result is that if you make up a database program—as I have; see last month's column for details—you must either recompile any time you change the database structure, or you must waste a lot of memory on larger than necessary arrays; neither choice is convenient.

Finally, BASIC-80 and BASCOM have a strange random-access file structure—and you cannot access the random files as if they were sequential. Microsoft's BASIC stores random files in a packed binary-code format that very efficiently uses the disk space; but the files aren't ASCII (American Standard Code for Information Interchange) standard and can't be printed by any program not written in Microsoft BASIC, and that can be a pain.

So: given the defects, what are the alternatives?

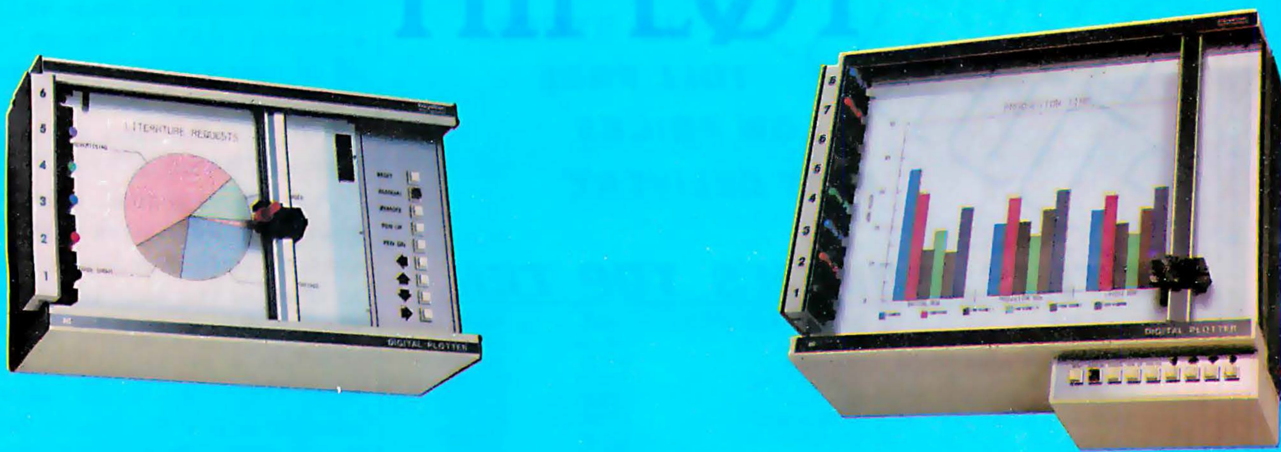
Digital Research's CB80

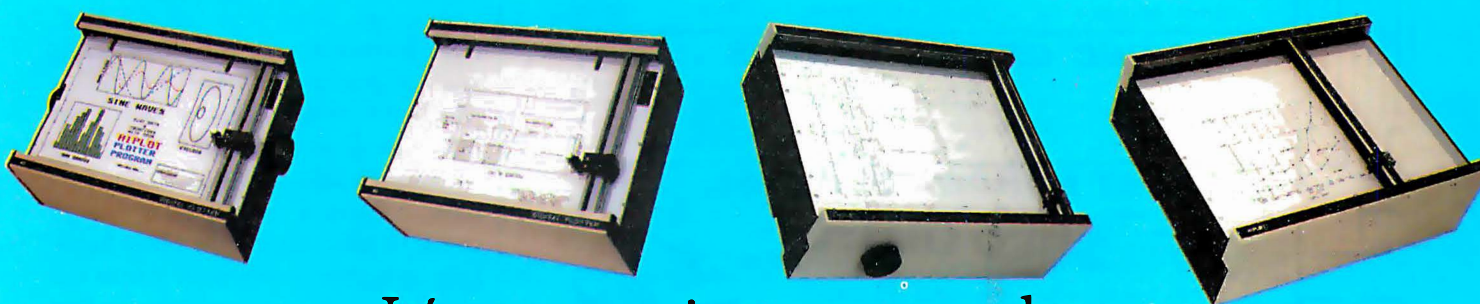
One solution might be to turn to Pascal and be done with it. Why mess with BASIC at all? Compiled Pascal MT+, or INT-file Pascal such as is created with Sorcim's Pascal M or UCSD Pascal, is supposed to be faster, easier to write, more efficient, and inherently better structured than the best BASIC ever written. (I'm not convinced; the few tests I've tried show BASIC programs compiled with BASCOM are about as fast as MT+ and *faster* than UCSD Pascal.)

Besides, now comes Digital Research's new CB80 to challenge the whole notion.

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User's Column

Gordon Eubanks, the author of CBASIC; and in a real sense CB80 is compiled CBASIC. You can compile all of your CBASIC programs with only minimal changes. Thus CB80 has all the advantages and disadvantages of CBASIC-2.

Advantages abound. CBASIC programs are nice to work with. Just for starters, you can redimension arrays as often as you like. You can access random files sequentially, and the file structure is standard ASCII for all files. There's a UCASE (uppercase) function and a nice search function that looks to see if what you want is embedded in anything else.

Another advantage of CBASIC over Microsoft's BASIC-80 is string space allocation; although CBASIC is a little slower in processing each input line (and slows down more and more as memory fills up), it does its "garbage collection" on the fly, so to speak. BASIC-80, on the other hand, runs at higher speeds until it runs out of string space—after which you find yourself completely locked away from your computer, unable to do any input or output or anything else for something like one to four minutes while BASIC-80 goes chasing through memory finding old strings the program has been told to forget. Eventually BASIC-80 clears everything up and becomes responsive again, if by then you haven't got so furious you've hit the Reset button.

So. CB80 is very nice. But, there's no interpreter. As with Pascal, FORTRAN, PL/I, or any of the compiled languages, creating large programs in CB80 takes a lot of time. First you have to create the program on an editor; then you compile it, finding a number of trivial syntax errors that you must fix by loading in your text editor and mashing the source program; then you compile again, then link, and then run with the run-time package. By the time you're done, you can use up an afternoon to develop a pretty simple program.

However, because CB80 is compiled and has no line numbers to fool with, you can put in *tons* of remarks,

meaning that if you come back to your program in six months you have half a chance of understanding it.

And actually CB80 is better than that.

Now it has labels. Instead of "GOSUB 3680" you can say "GOSUB COUNTIT", or "GOSUB PROCESS.ONE.ITEM". Better yet, you can have very complex functions, which you call and pass parameters to; and the functions use purely local variables that can't affect anything in the program outside.

The functions can take up many lines, and they can be "external," meaning that the function can be in an entirely different program "module" that gets called in at link time. Multiple-line functions can also access and change external variables; and the whole mess can be called by value, as in the statement "WHILE FARNUM(FOO)" where "FARNUM" has previously been defined as a function of the variable "FOO."

More yet, a multiline function can have both purely local variables and variables created just for that function (the variable "X" in the function is not the same as the variable "X" in another function or in the main program) and can *also* affect regular global variables in the rest of your BASIC program. This means you could have a function called "YES" that prints a prompt, gets an input, checks to see if the first letter of that input is either "y" or "Y," and informs the main program.

In other words, CB80 has got pretty darned close to Pascal's functions and procedures, and it seems to be a lot faster than Pascal too. You could sit down and write a really neat set of "software tools." You can, with CB80, build a whole library of useful program modules, setting them up in nice orderly blocks to be called in when needed.

That, of course, is the answer to the "no interpreter" problem: build a set of functions that you know will work and include them in the new programs you write. After a while you'll find that most programming consists of stringing together routines known to be reliable and once in a while developing a new function to stick into your tool kit.

Although CB80 is marketed by Digital Research and the manual flies Digital's colors, don't despair: the documentation wasn't really written by Digital, meaning that it's not encrypted and translated into Swahili, as much of Digital's documentation is. It does have some of the fine hand of the Digital hacker about it; for example, the text is peppered with incomprehensible "syntax diagrams," as if they were supposed to mean something; and here and there the sentence density gets completely out of hand. For the most part, though, the CB80 manual is in the really excellent style of the old CBASIC manual: clear, concise, and with plenty of examples. You need not be afraid of it.

You might, however, be afraid of CB80's price, which is steep, and its licensing policy, which is sheer madness: that is, Digital Research wants a flat $2000 a year if you're going to compile, link, and market programs using CB80. (The fee applies only to programs you distribute, not to those developed for your own use; still, it's onerous enough.) Again, I suspect competition will bring this down; meanwhile, we can wait. . . .

Which Language Now?

So. We have increasingly better BASICs, and one of these days we'll get a compiled language as good as CB80 with an interpreter as good as Microsoft's BASIC-80. When that happens, I think FORTRAN and COBOL and even Pascal are going to suffer a sharp drop in popularity.

My mad friend, meanwhile, continues to praise PL/I, which he says is easy to learn and remarkably effective. I confess I haven't had time to write anything but the simplest programs in PL/I or indeed even had time to examine it; but my mad friend is usually fairly reliable in his judgments and has a very healthy attitude toward computers, namely that they're for him to use and are not masters that control him.

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Data Base Management

Data management packages were created to save time and money in the development of software solutions to information problems. Many have been designed to accomplish just that, although most have only the programmer in mind. Sure they would save time in the long run, but what of the initial investment in time and effort required to learn the new language? What about the non-programmers in the world who would like an easy yet powerful applications generator? The solution is one of the most highly acclaimed software packages of our time, T.I.M. III.

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Accounts Comprehensible

Once again I find myself embarrassed: I have to review a program I've written.

I have most of the many computer accounting packages available. Some, I guess, are really swell for what they do; but not one of them, *not one*, looks too useful for *me*.

I'm a writer. A good part of my life is deductible. It's amazing just how many activities turn out to be income-related research. And it comes as no surprise that the Internal Revenue Service is very interested in the records demonstrating that.

And therein lies the problem. Sure, I could hire an accountant. Many of my colleagues do, and a lot of them think I'm crazy when I tell them I keep my own books and make out my own tax returns. And yet, when I begin to question those colleagues, I find that I don't work any harder than they do. By the time they've explained everything to an accountant, turned in all the receipts, and kept all the records and diaries that the accountant wants, they've usually done *more* work than I do; and they pay more taxes too.

I've always kept my own books; one of the main reasons I let my mad friend talk me into buying Ezekial, my Z80, was the hope that I could computerize my accounting system. Thus I have for *years* pounced on every new accounting program eagerly and I've been disappointed every time.

Most "accounting" programs don't produce what I would call accounting books. Instead, they offer "special reports." Now understand: I don't know a darned thing about accounting. Everything I think I know came from two books, Donald H. MacKenzie's *Fundamentals of Accounting* and John N. Myer's *Accounting for Non-Accountants*. Those books explain what accounting is all about; and with pictures and illustrations, they give actual examples of journals and ledgers with the funny single, double, and triple lines, the complex scheme of indentations, and the strange check marks favored by accountants. And as far as I'm concerned, that's what my company's books ought to look like.

Nor am I completely mad; every couple of years I have my boys drift into the local university bookstore and buy all the accounting textbooks they can find, and I look through them; and lo!, the textbooks still show that accountants like double and triple lines, and complicated indentations, and. . . .

Yet, there's no computer accounting program that I know of that produces books that look like the books in the accounting texts; and because that's the only thing I could understand with my cookbook knowledge of accounting, I had no real choice. I had to write programs that *do* make journals and ledgers that correspond with the examples in the elementary accounting textbooks.

Which is what I did. My account-

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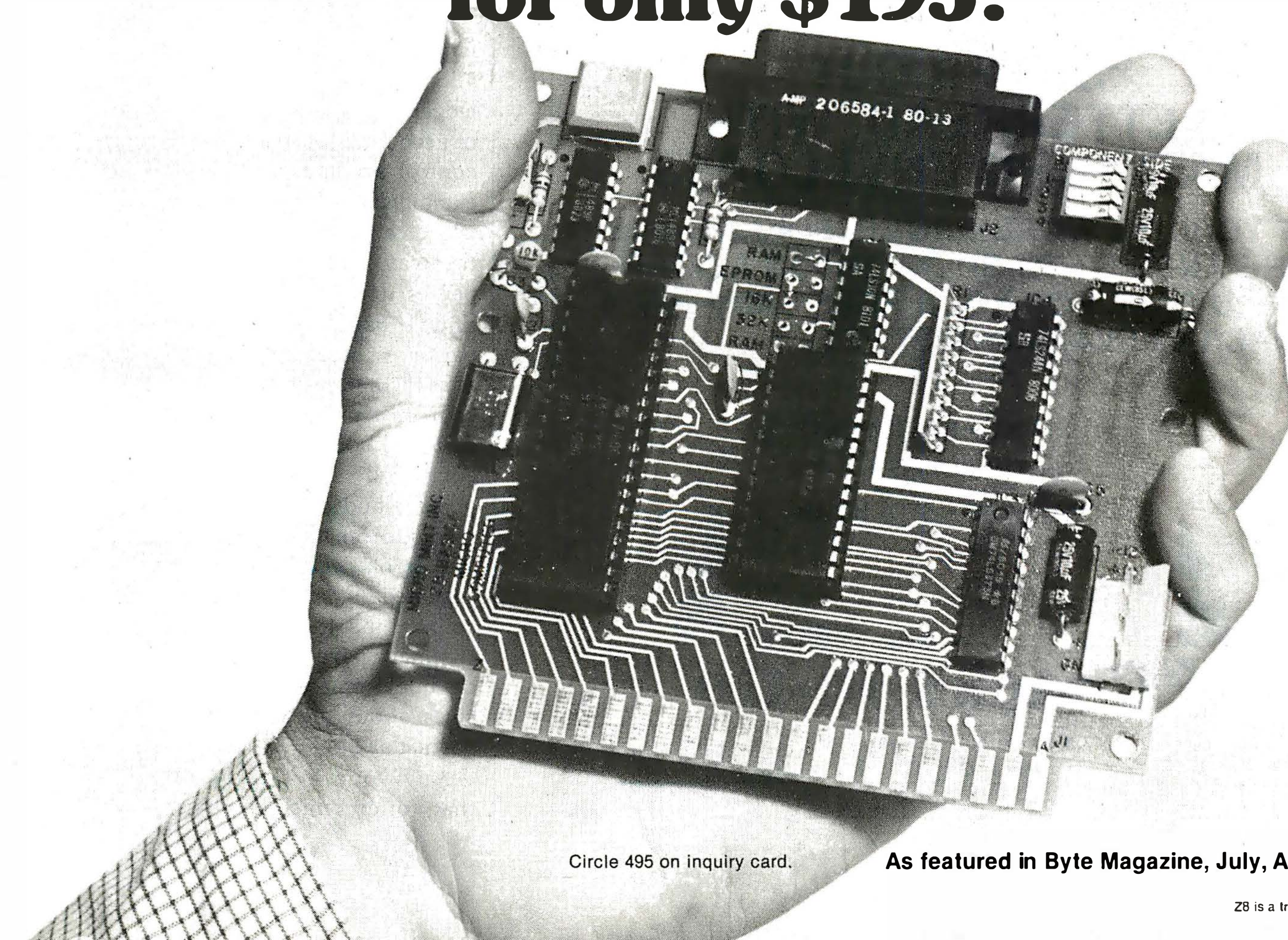
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ing system starts with a simple-minded thing that lets you build a chart of accounts, essentially a list of ledger page names each with a corresponding ledger page number: for example, 501, postage; 506, office supplies; 506.012, travel supplies; 523, business charitable contributions; 923, family charitable contributions.

You can add to the chart of accounts at any time, and you can use fractional page numbers, from .001 to .999, if you like, because each ledger page will become a CP/M file title "LED-xxx.yyy," as for example LED-506.012.

After you make a chart, you use the Journal program to build journals. A journal entry consists of a line that indicates to whom you paid (or from whom you received) something, a longer explanation line, an amount, and a series of debits and credits that the program keeps track of (I hate to remember that when you spend money you *credit* cash and *debit* the account you spent it on). The program will not allow you to enter an item that doesn't have equal debits and credits.

You can put stuff into the journal in any order you want; there is then a program that will allocate the journal entries by date, so that the journal becomes a chronological record of what you spent and for what. The program has ways of entering cash, checks (from more than one account if you like; I have two interest-bearing checking accounts and one commercial account, and I need to keep them all straight), a dozen different credit cards, and so forth. It also keeps track of check numbers.

Once you've built a journal, you can print it; that requires a printer that can print solid vertical bars (ASCII character 124 in decimal) in order to reproduce the single, double, and treble lines so loved by accountants.

You can then use the Post program, which takes the journal entries and allocates them among the various ledger pages you created in the chart of accounts. Journal has provision for control accounts. I suppose I better explain that. Let's say a primary expense category is postage, and that's the way I intend to report the expenses to the IRS. However, I often find I have to send express mail packets. These ought to be charged to a particular project—in my case, of course, a project is a book. Thus I debit the book account and credit the controlled account; I also debit postage and credit cash. When I get income from that particular project, the book gets credited, as does "agented income," while the bank account's and the controlled account's summary pages get debits; once again the books balance, and I can get some clues about the profitability of any particular book.

Anyway, Post takes care of all that, after which another program



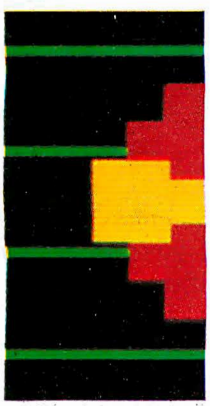
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Block Mosaic



Geometric

Ease of Operation

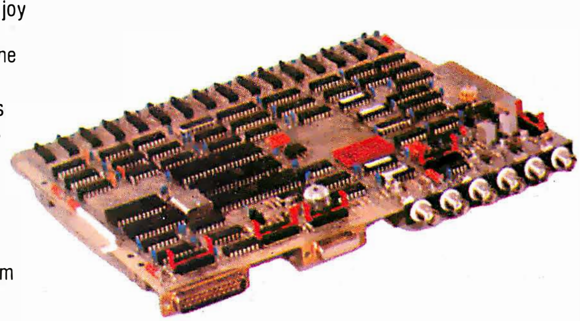
By virtue of the Picture Description Instruction (PDI) protocol used in Telidon Systems, images may be created from familiar graphic primitives such as points, lines, arcs and polygons. This same presentation level protocol is recognized as an international videotex standard and forms the kernel of the protocol selected by AT & T for their image communication networks. The use of an 8 bit data format, ASCII standard characters and RS232C serial communication, enhances the general purpose nature of the NORPAK display generator.

Applications

The compact size and low power consumption of the basic module facilitates integration into a complete display unit which may include a monitor and other specialized communications interfaces. It may be used as a simple output device connected to a computer or may form part of a stand-alone workstation. Many users who have been introduced to the potential of color graphics, through low resolution mosaic displays, will enjoy the increased spatial resolution of the pixel oriented raster bit plane technology. Some of the many potential applications include:

- display generator for VIDEOTEX applications
- output device for system status in a process control environment
- business graphics generation
- student display for educational applications
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Circle 305 on inquiry card.

prints all those ledgers. Each ledger entry contains a reference to the journal page and item number, so there is a complete audit trail back and forth; indeed, the whole thing looks exactly like the demonstration items given in Myer's *Accounting for Non-Accountants*, which ought to be no great surprise since that's what the programs were designed to do.

Now note: the programs do not give a lot of "special reports." They don't claim to do a darned thing that isn't covered in the Myer book (which is still in print, published by E. P. Dutton, 1980). But they do create books that look like what accounting texts expect, which was all I set out to do.

And since my business gets confused with my family's affairs, I've made it easy to segregate business from family expenditures (for example, cases where the kids come on business trips and thus have to have their expenses charged to a different account from mine. That sort of thing).

I've used these programs since 1977. Eventually some of my friends asked for copies. Then more. Then I was asked to write up a little manual on how to use the programs, and while I was at it, why not include a brief treatise on what accounting is for and. . . .

It was getting out of hand, and one night over the slivovitz, Barry Workman got at me with an offer to publish the programs. "After all," he said, "they really are the best accounting programs you know of, aren't they?"

"No. Just the best for the kind of small business I operate. I don't know how good they'd be for an outfit that has lots of accounts receivable and accounts payable, or a big payroll."

"I use your accounting programs," Barry pointed out. "And so do a number of your friends. Consulting engineers and a couple of freelance salespeople use it; you know, your programs produce standard ASCII files that can be manipulated to be the input to much more complicated routines if anyone wants more massaging than your stuff gives them."

And so forth. So eventually I agreed, and now I'm in the embarrassing position of reviewing my own software. All I can say on that score is that I do use the programs; they do work for my kind of small business. They are *not* heavy on accounts receivable and accounts payable; they're *far* more useful for recording expenses and income in complex ways than they are for controlling monthly billings. (Writers don't have monthly billings.) Given those limits, they are pretty good. They do make books that you can read and that your accountant will recognize. They preserve the audit trail, and they let you have as complex—or as simple—a chart of accounts as you like.

My mad friend tells me that my little treatise on why one keeps books in the first place is the only thing on that subject he's been able to make sense of; but do recall that he's quite mad.

Use dBASE II Instead?

I described my accounting package to George Tate of Ashton-Tate, the outfit that distributes dBASE II and WRITE, and he recommended that I throw it away and build an accounting system out of dBASE II. I haven't done that and I'm not likely to, but I'll have to confess that I see his point. Every time I play with dBASE II I find something else to like about it; unlike some programs, this one wears well, and I think you really could construct a pretty good accounting system from it. In fact, I *know* you can because I've seen some of them in operation.

I also have Quickscreen, a "screen builder" program designed for use with dBASE II and Microsoft BASIC. I like Quickscreen. I asked George Tate about it, and he told me a number of his programmers like to use it when they're doing programs in dBASE II, which is a pretty powerful recommendation. Quickscreen lets you build up a form, such as a letter-

head or a shipping label, or anything like that, which includes lines and permanent labels (such as "Bill To:" or "***TOTAL***") as well as variables. You then save the form on disk, and when you call it again, the form returns with values for the variables from a dBASE II file. It all looks very useful, and the manual seems reasonably clear. I confess I haven't done a lot of experimenting with Quickscreen, but people I respect use it with no trouble.

Next time, more on new hardware, including, I hope, the IBM Personal Computer.■

Software Reviewed

Sorcim Corporation
405 Aldo Ave., Dept. A1
Santa Clara, CA 95050

Supercalc CP/M	$295

Cornucopia Software
POB 5028
Walnut Creek, CA 94596

Microproof	$169
correcting option	$60

MicroPro International Corporation
1299 Fourth St.
San Rafael, CA 94901

Spellstar (for Wordstar) Apple	$195

Microsoft Inc.
10700 Northup Way
Bellevue, WA 98004

BASCOM compiler for BASIC-80	
CP/M and Apple	$395
TRS-80 Model I	$195

Digital Research
POB 579
Pacific Grove, CA 93950

CB80 compiler for CBASIC	$500

Workman & Associates
112 Marion Ave.
Pasadena, CA 91106

CBASIC Accounting for Non-Accountants	8-inch single-density CP/M disk	$245

Fox & Geller Associates Inc.
POB 1053
Teaneck, NJ 07666

Quickscreen for FMS-80, dBASE II, CBASIC, Microsoft BASIC-80	56K-byte CP/M	$149

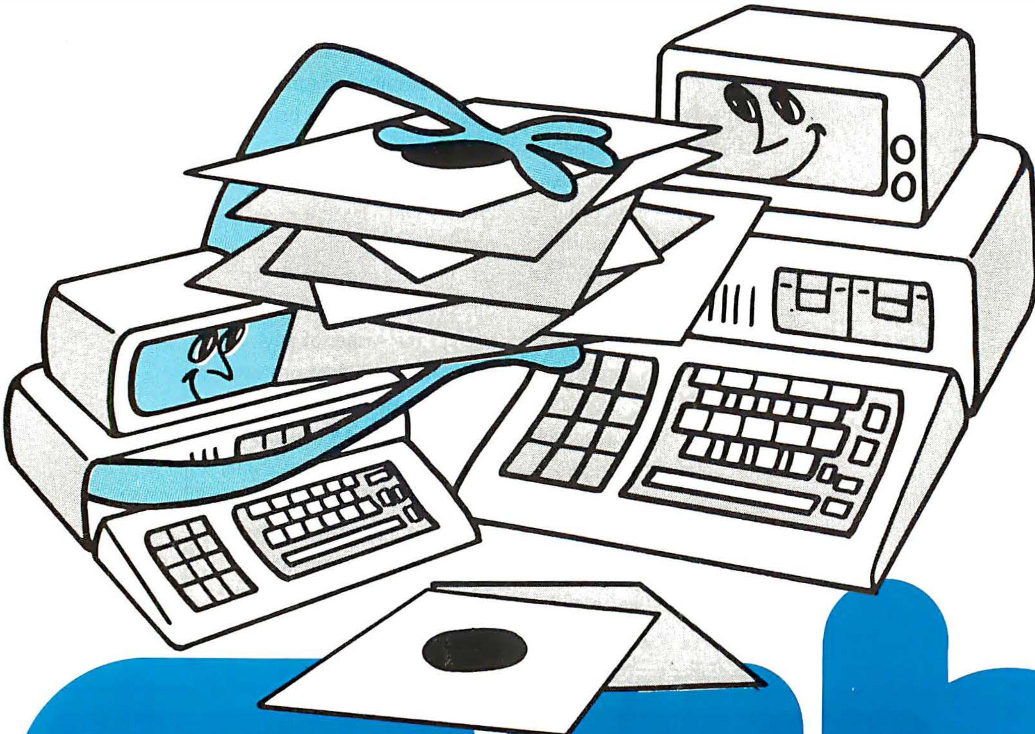
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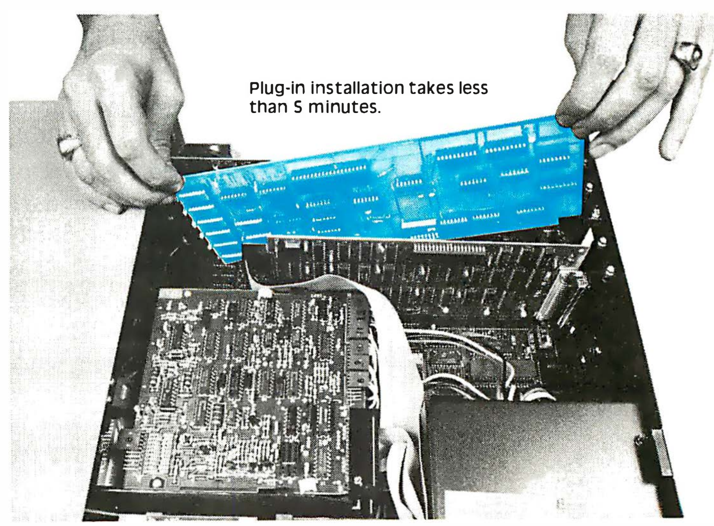
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PL/I for Microcomputers

John A. Lehman
716 Hutchins #2
Ann Arbor, MI 48103

PL/I was originally developed by IBM as the language of choice for the 360 computer series. As such, it was expected to replace FORTRAN, COBOL, ALGOL, and assembler language. The original PL/I was a huge language with more features than a hundred-blade Swiss Army knife. It was inconvenient because it required large chunks of expensive memory and considerable feats of recall on the part of programmers who were trying to remember its features.

Several years ago, ANSI (American National Standards Institute) issued PL/I standards for both a full and a subset language. The latter was named the G subset and was intended for minicomputer use. It preserved all of the really useful features of full PL/I but cut it down to a manageable size. Implementations are available for most of the popular minicomputers and for any microcomputer that runs CP/M (version 1.4 or later) or MP/M.

Digital Research's PL/I-80 implements all of the level-G features except DEFINED, FLOAT DECIMAL, LIKE, ATANH, DATE, TIME, STRING, and VALID. DATE and TIME are operating system functions that are not supported by CP/M. FLOAT DECIMAL (binary-coded decimal floating-point arithmetic and data storage) is seldom used; FLOAT BINARY (which is supported) is used instead.

The linkage editor (LINK-80), which is included, supports overlays, indexed libraries, and Microsoft .REL files. This means that subroutines compiled under Microsoft FORTRAN, COBOL, and BASIC can be used by PL/I programs. (I can only vouch for the FORTRAN features because I don't have the other two compilers.) A version of the Digital Research MAC macro assembler (called RMAC), which produces relocatable code, is included; thus assembler subroutines can also be used. Assembler source libraries to access all CP/M and MP/M system features are included, as is an entire disk of sample programs. A .SYM file is generated, so Digital Research's SID (a symbolic debugger) can be used for debugging with symbolic constants.

At a Glance

Name: PL/I-80
Type
High-level-language system
Manufacturer
Digital Research
POB 579
Pacific Grove, CA 93950
Price
$500 ($35 for documentation alone)
Format
Two 8-inch floppy disks (other formats available)
System Requirements
CP/M version 1.4 or higher, MP/M, 8080,8085, or Z80 processor with 48K bytes of memory and two 8-inch disk drives (an 8086 version is also available)
Documentation
Language manual, operator's guide, applications guide, and pocket reference guide.
Audience
Language enthusiasts, applications and system programmers

Performance

As a combined scientific, business, and system programming language, PL/I isn't as elegant as Pascal or as easy to use as BASIC. It does provide most of the facilities of FORTRAN, COBOL, ALGOL (Pascal), BASIC, and assembler language in a form that encourages structured programming. Generally, programs written in PL/I are much more understandable than those written in BASIC, FORTRAN, COBOL, or assembler language (see listing 1). PL/I is not as clear as Pascal, but it has much better facilities for file management and system programming. Its primary advantage as a programming tool is that you can do *all* of your programming in one language.

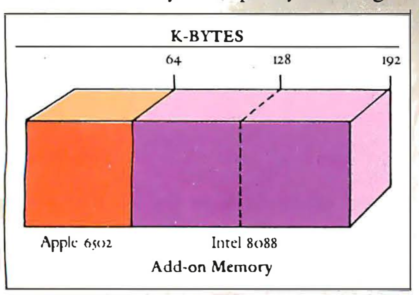
This advantage is especially apparent to those of us who use several different computers. I can write a single program in PL/I and run it on my Z80 at home or on the Amdahl, Honeywell, or IBM Series/1 at work. My wife can write programs at home and run them on the IBM 370 OS/VS2 system at work. Any of these programs can also be run on an 8086, a PDP-11, and a NOVA, among others. The only other languages that allow such transportability are FORTRAN and COBOL. I'm allergic to COBOL, and although FORTRAN is my native computer

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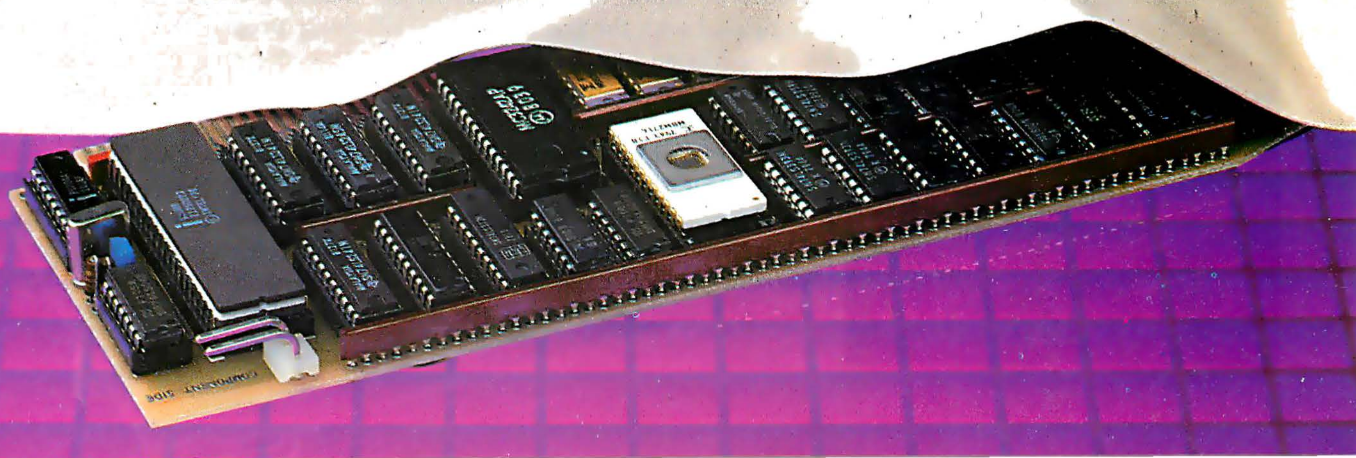
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Listing 1: *The HYPOCY program. This sample program shows the easily understood structure of a PL/I program. The program will draw the curves traced by a point on a circle while that circle is rolling internally on the circumference of another circle.*

```
hypocy:
     proc options(main);
     /* Plots hypocycloid onto Microchroma 68 */
     /* graphics board using raster addresses which*/
     /* is set up as cp/m punch device.  */
     /* polypx and initgr are separately compiled (assembled) */
     /* routines to send groups of dot coordinates and */
     /* to initialize the graphics hardware respectively */
     dcl  initgr entry,
          polypx entry (fixed,(0:255) fixed,(0:255) fixed);
     dcl
          (x,y,theta,templ,temp2,temp3)float,
          (sines(0:255),cosines(0:255)) float,
          (i,ix(0:255),iy(0:255),count) fixed;
     dcl
          forty  fixed initial(40),
          one_hundred fixed initial(100),
          seventy_five fixed initial(75);
   call initgr;
     count=255;
circle:
     do i=0 to count;
          temp3=float(i);
          theta=temp3/40;
          sines(i)=sin(theta);
          cosines(i)=cos(theta);
          x=cosines(i)*seventy_five+one_hundred;
          y=sines(i)*seventy_five+one_hundred;
          ix(i)=fixed(x);
          iy(i)=fixed(y);
     end circle;
     call polypx(count,ix,iy);
hypo:
     do i=0 to count;
          temp3=float(i);
          templ=cosines(i);
          temp2=sines(i);
          x=templ*templ*templ*seventy_five+one_hundred;
          y=temp2*temp2*temp2*seventy_five+one_hundred;
          ix(i)=fixed(x);
          iy(i)=fixed(y);
     end hypo;
     call polypx(count,ix,iy);
     end hypocy;
```

language, it's not suitable for nonnumeric or data-intensive programming.

So much for why you should use PL/I. How well does it work? Table 1 compares run times (in seconds on a 2-MHz Z80) for PL/I-80, Microsoft FORTRAN, and XBASIC (TDL/Xitan Extended Disk BASIC). The test programs were basically textbook examples, iterated enough times to make timing feasible. XBASIC is included to show how an interpreter compared with the compilers.

One hidden "gotcha" showed up in the tests. PL/I interprets numeric constants as fixed decimals and converts them to fixed binary-coded decimals each time arithmetic operations involving the latter are performed. Thus, using constants (rather than variables which have been set to a desired value) will increase the duration of execution by as many as fifty times.

In practice, the only time slow run speeds have presented a problem with PL/I has been during interactive video graphics. Otherwise, a floppy-disk-based system is usually so badly disk-bound that the efficiency of the code produced by the compiler doesn't matter much. This characteristic is slightly irritating because both the compiler and the linker make heavy use of the disks; consequently, long programs can take more than five minutes to compile or link. A hard disk would presumably help this. Even so, PL/I-80 and Link-80 work faster with floppy disks than their IBM Series/1 equivalents do with hard disks. They have fewer bugs too.

Version 1.3 of PL/I-80 *appears* bug-free; at least I haven't found any.





	PL/I	FORTRAN	XBASIC
10,000 iterations	0.5	0.3	20.8
10,000 fixed-point additions	0.9	0.5	NS
10,000 fixed-point multiplications	6.8	0.5	NS
10,000 floating-point additions	10.0	8.4	48
10,000 floating-point multiplications	15.5	14.9	57
10,000 dummy subroutine calls	0.6	0.6	42
10,000 cosine calculations	35.0	23.0	63

Table 1: *The results, in seconds, comparing various languages' performance of standard functions on a TDL/Xitan S-100 system with the Z80 running at 2 MHz. The languages were Digital Research's PL/I-80, Microsoft FORTRAN, and XBASIC (TDL/Xitan Extended Disk BASIC). (NS indicates function not supported.)*

Earlier versions had problems that were quickly remedied. Version 1.1 (a major upgrade) was sent out free of charge on disk. Version 1.2 was distributed in the form of a free patch sheet. Version 1.3 (with more upgrades) was available for $25 on disk to owners of the earlier versions.

Conclusions

The current version of PL/I-80 provides a nearly full ANSI level-G system with excellent facilities for linking and overlays. The file format is compatible with Microsoft compilers and thus allows use of existing program and subroutine libraries with PL/I. Full access to CP/M and MP/M facilities is also provided.

PL/I is a more powerful language than FORTRAN, COBOL, Pascal, or BASIC. This implementation allows access to all commonly used features of PL/I. It's intended to facilitate both applications and systems programming. The current version for microcomputers is remarkably bug-free and is source-compatible with the dialects used on many mini- and mainframe computers. Thus, users can take advantage of existing software or develop software for larger machines on CP/M-based systems. The existence of an 8086 version promises continued compatibility with more powerful hardware.

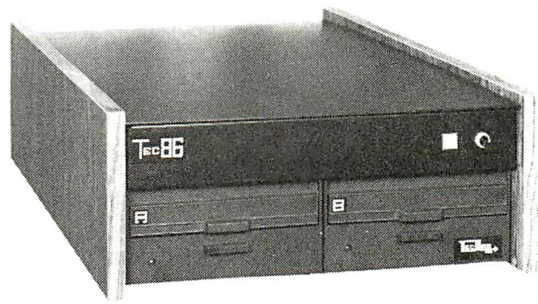
Support from Digital Research is excellent. The only difficulty commercial users will encounter is the necessity of licensing use of the run-time library in third-party software products. This is offset by Digital Research's assistance program for OEM customers.■

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San Antonio, TX 78216

The Apple II computer's video-display section was designed with an ordinary television set in mind. This design choice limited the Apple's screen to 40 characters per line because of the limited resolution of ordinary color television sets. Of course, this arrangement allowed Apple II users the option of using their home television set, rather than requiring them to purchase a more expensive video monitor or terminal. However, as the popularity of the Apple II grew, software developers began to write programs that made applications such as accounting and word processing possible. These applications often require a professional-quality 80-character-per-line display. It's not surprising, then, that several enterprising manufacturers have developed Apple II interface cards to provide the more or less standard 24 lines of 80 uppercase and lowercase characters. (See photo 1, page 256.) I have reviewed five popular interface cards, Omnivision, Full-View 80, Smarterm, Sup'R'Terminal, and Videoterm, and this article surveys their characteristics and compares their features.

All the 80-column boards use a large-scale integration (LSI) device, either Motorola's 6845 or Synertek's 6545, as the "heart" of the display circuitry. Because of this, you might think that the boards would be very similar, but each has different features, and they are not entirely compatible with one another or with the standard Apple II software. Yet they do have features in common: all generate uppercase and lowercase characters and require a good-quality black-and-white monitor (not a black-and-white or color television set) for best results. (See the text box "A Fast Scan of Video Monitors," page 254.)

Accessing the Boards

All the boards are accessed by using the standard Apple II conventions for getting at peripheral devices. For example, the familiar PR#*n* instruction, where *n* is the slot number of the peripheral device, can be used to activate the video boards. The Apple II permits only one peripheral device to be active at a time, so this can pose some difficulties if the board is intended to be used simultaneously with a modem (or serial interface, etc.). Another important consideration is that each board interprets certain control characters as commands to perform special functions. These control characters usually cannot be used by programs for other purposes. Moreover, Integer BASIC does not have the CHR$ function required to generate the control characters.

Characters are formed on the video display as a matrix of dots within a field of fixed size. (See photo 2, page 257.) Common character sizes are 5 by 7 or 7 by 9 dots. As an example, a character may be formed from a table of dots having 5 columns and 7 rows, within a field of 6 columns and 13 rows. The unused rows and columns in the field provide the spacing between characters on a line and between lines of characters. The lowercase characters g, j, p, q, and y are generally easier to read when they are allowed to extend down into the lower rows.

Usually, 7 by 9 dot characters can be made to have a more pleasing appearance than 5 by 7 dot characters, due to the higher resolution; however, this may not be apparent unless a higher-bandwidth monitor is used. I suggest that you test the video board with the monitor you intend to use to ensure acceptable character appearance.

A Fast Scan of Video Monitors

The video image produced by the Apple II and many other personal computers is called a raster-scan display. The image is made up of several hundred horizontal lines of several hundred tiny dots. In a normal television picture, there usually are 262 lines per frame and fewer than 200 dots per line. This allows fewer than 40 characters per line, with a 5 by 7 dot matrix. Lines of dots are displayed at the rate of 15,750 lines per second, so the video bandwidth would be 200 times 15,750 Hz, or about 3 MHz.

Try a test run before you buy

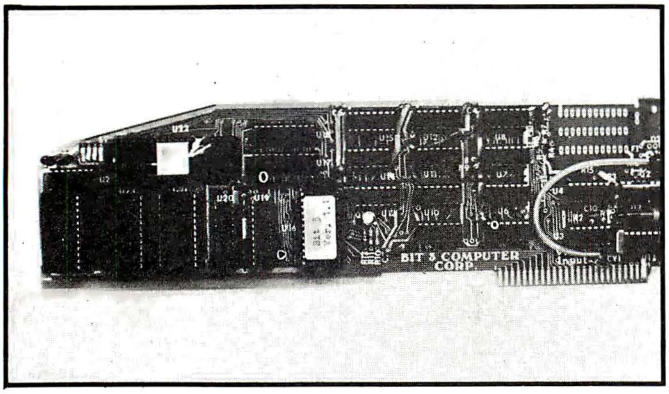
To display a line of 80 characters in a 7 by 9 dot-matrix format would require about 800 dots per line and a video bandwidth of 12 MHz (18 MHz is not uncommon in expensive units).

Some of the video boards in this review generate acceptable images only on monitors. This means that buying an 80-column board may also necessitate the purchase of a monitor, unless you already have one with enough resolution and bandwidth. Monitors are available through most computer dealers, but stick to name brands such as Hitachi, Amdek (formerly known as Leedex), Motorola, NEC Home Electronics, Panasonic, Zenith, etc.

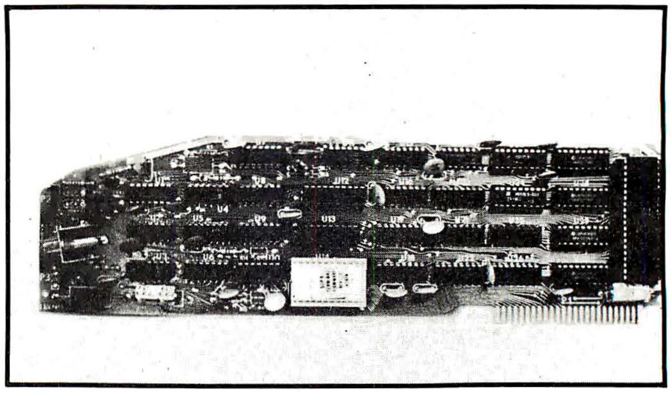
If you have a monitor but are unsure of its suitability for use with the board you have selected, try a test run in a dealer's showroom before you buy. Keep in mind that some of these 80-column boards use more of the video field, so the height and width controls may need to be adjusted.

Photo 1: *Five 80-column video-interface boards for the Apple II computer. The photos are Full-View 80 (1a), Omnivision (1b), Smarterm (1c), Sup'R'Terminal (1d), and Videoterm (1e). Features vary, but most users will need a video monitor to appreciate the full quality of the displays produced.*

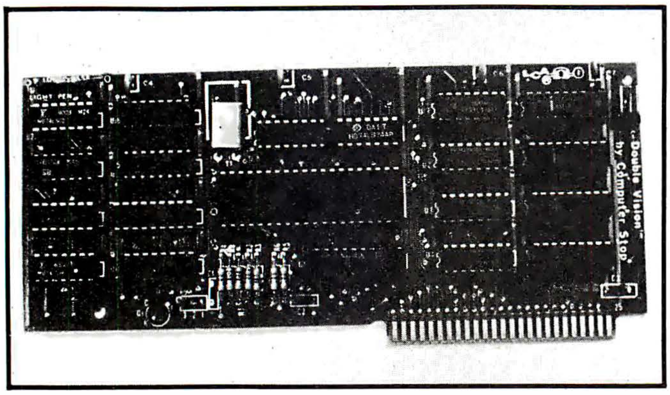
1a



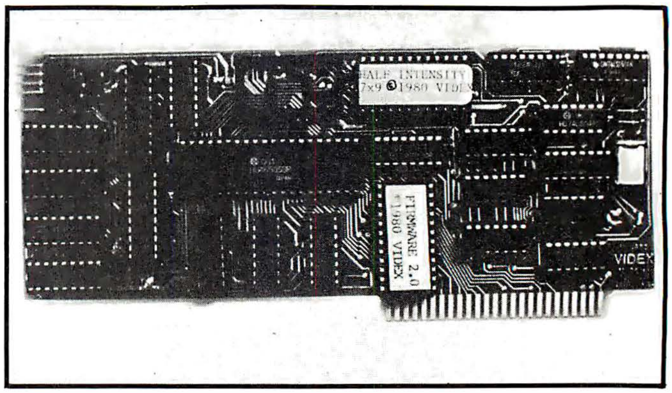
1d



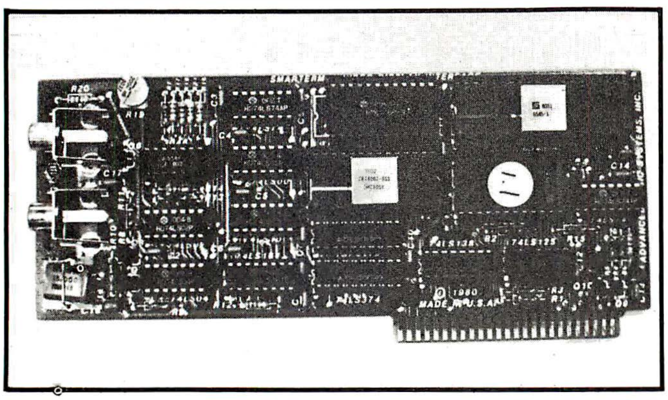
1b



1e



1c



All the boards store the character-dot tables in a read-only memory (ROM). Full-View 80, Sup'R'Terminal, and Videoterm allow an alternate character set to be selected from another ROM or from programmable memory. The alternate character set can be used for foreign languages or for special graphics characters. This is an important feature when special character fonts are needed for word processing or a programming language such as APL.

Compatibility

In selecting a video board, software compatibility must be considered, particularly if you plan to use the board with off-the-shelf software packages. Many word-processing packages are customized for specific 80-column boards. If you are already using a particular word processor, you may want to be sure that a version of that program is available for the video board you intend to use. Most dealers can demonstrate the operation of programs with the video board. If a dealer is reluctant to demonstrate a particular program running with a given video board, beware; there may be a problem with that combination.

Program-compatibility problems are usually the result of two conditions: difference in display size and difference in control functions. For example, HOME, VTAB (vertical tab), and INVERSE (black on white) commands are not supported by all the boards. None of the boards reviewed here supports the Flash Mode of the standard Apple II video display. All offer some support for Pascal.

When the system is initially loaded, the Pascal-language system examines interface-slot 3 for a peripheral card. If an interface card is present, the Pascal system attempts to use that interface as its console device. The video boards, therefore, must be placed in slot 3 to be used with Pascal. All the boards support the Z80-based Microsoft Softcard and Digital Research's CP/M. Again, the board must be in slot 3 to be used.

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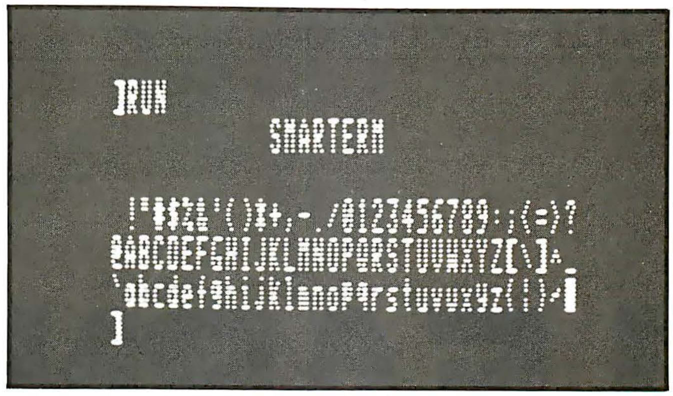
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Photo 2: *Sample video displays of the five 80-column video-interface boards. Photos 2a through 2e correspond to the 80-column boards in photo 1.*

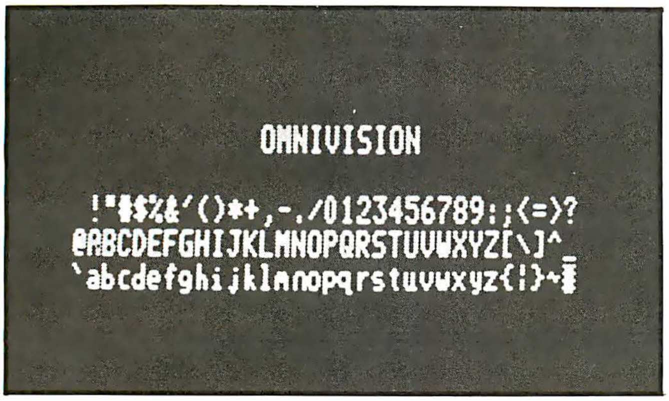
2a



2c



2b



2d



2e



When you shop for a video board, you must consider two areas of hardware compatiblity. The first is how the video signal fed to the monitor is switched between the video board and the Apple II's normal display output. The second is how uppercase and lowercase characters are entered from the keyboard.

Full-View 80, Smarterm, and Videoterm support either a manual video-signal switch or a software video-signal switch. The software switch, however, requires modification of the existing software because the BASIC commands TEXT, GR, and HGR are not compatible with it. A similar problem is encountered with the Pascal Turtlegraphics unit. The boards can, of course, be used with two video displays. If this is done, both monitors can display information at the same time. If color graphics or simultaneous high-resolution graphics and 24 by 80 text displays are desired, then two monitors must be used, and video switching is not a problem.

The Apple II keyboard is a teletypewriter-compatible keyboard, but it does not generate all of the American Standard Code for Information Interchange (ASCII) character codes. In particular, the lowercase alphabetic characters and certain special characters, such as {, }, and [, cannot be generated. The video boards use a control character, such as ESC A (two keystrokes, the ESCAPE key followed by an A key) or CTRL-A (one keystroke, CONTROL-A), to indicate that the subsequent character is uppercase. Two consecutive control characters toggle the keyboard into a shift-lock mode.

Such conventions for shifting usually make those control characters unavailable for use by a program. All five boards support a hardware modification to the Apple II computer (which invalidates the warranty) that involves connecting the shift-key switch and the game-paddle connector, pin 4. When this modification is performed, the shift key can be used as with a standard typewriter.

At a Glance

Name
Omnivision

Use
80-column video-display interface for the Apple II or Apple II Plus

Manufacturer
The Computer Stop
16919 Hawthorne Blvd.
Lawndale, CA 90260
(213) 371-4010

Price
$295

Features
Character appearance: 5 by 7 dot matrix; inverse video; character generator in programmable memory

Software
Software on disk, compatible with Integer and Applesoft BASIC, Apple Pascal, and the Microsoft Softcard; Apple cursor editing; supports Pascal type-ahead buffer

Hardware
Motorola 6845 LSI circuit; light-pen input port; consumes 3 watts

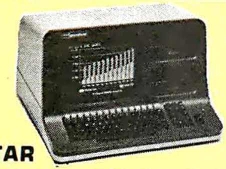
Omnivision

Computer Stop's Omnivision supersedes an earlier board known as Doublevision. The Omnivision board is, however, completely software compatible with the Doublevision. Omnivision is an 80-character video-display board and the only board reviewed here that does not have its software in ROM. The software drivers are supplied on 5¼-inch floppy disks, one for the standard Apple disk operating system (DOS) and the other for the Pascal-language system. (The Pascal language driver is provided for an additional $25.) This means that a disk-based computer is required for use of Omnivision. Because the software is loaded into user-programmable memory, rather than ROM, it can be changed easily.

Omnivision supports a lowercase mode in which the ESC key is used to indicate that the next character is capitalized. The sequence ESC ESC enters the shift-lock mode. A hardware shift-key modification, where a wire is soldered to the Apple II's shift key at one end and attached to the Omnivision card at the other, is supported. In addition, Omnivision supports the Microsoft Softcard.

Characters are formed from 5 by 7 dot matrices without lowercase descenders. Neither a software-controlled video-signal switch nor a manual switch is provided. Complete program listings are provided in the documentation, which consists of a 60-page manual.

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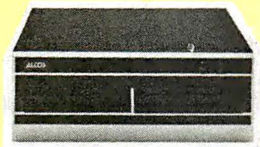
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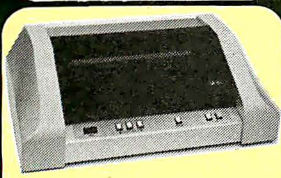
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At a Glance

Name
Full-View 80

Use
80-column video-display interface for the Apple II or Apple II Plus

Manufacturer
Bit 3 Computer Corporation
8120 Penn Ave. S.
Minneapolis, MN 55431
(612) 881-6955

Price
$379

Features
Character appearance: 5 by 7, 7 by 9, or 8 by 10 dot matrix, lowercase descenders; inverse video; character generator in EPROM; supports alternate character set in EPROM (option: $47); graphics

Software
Software in ROM, compatible with Integer and Applesoft BASIC, Apple Pascal, and the Microsoft Softcard; Apple cursor editing; supports Pascal type-ahead buffer

Hardware
Synertek 6545 LSI circuit; light-pen input port; consumes 2.5 watts

Full-View 80

Full-View 80 from Bit 3 Computer Corp. has onboard control software, the latest version being revision 1.2. Software switching of the video signal is supported.

Characters can be formed from 5 by 7, 7 by 9, or 5 by 9 dot matrices (within an 8 by 10 dot framework); however, the 7 by 9 format requires a higher-quality monitor. An optional erasable programmable read-only memory (EPROM) adapter that allows the user to define custom-character fonts is available for $47. Full-View 80's display fully supports the Pascal-language system and the Microsoft Softcard when used in slot 3. Pascal keypress and type-ahead functions also are supported.

Full-View 80 supports the hardware shift-key modification. Without the keyboard modification, in the lowercase mode a CTRL-A is used to indicate that the next character is uppercase, while the sequence CTRL-A CTRL-A locks the keyboard in uppercase.

Full-View 80 has escape codes for entering certain frequently used commands such as HOME, CATALOG, LOAD, and RUN with two keystrokes. A stick-on legend for these codes is provided for the keyboard. Full-View 80 has a light-pen input, but a light-pen option is not offered at this time. Also, a 60-Hz nonmaskable-interrupt source is available. This can be used to provide a clock in software. Full-View 80's screen memory can be read by programs. The documentation consists of a 37-page manual; no source code is given.

At a Glance

Name
Smarterm

Use
80-column video-display interface for the Apple II or Apple II Plus

Manufacturer
Advanced Logic Systems Inc.
Suite 1009, 491 Macara Ave.
Sunnyvale, CA 94086
(408) 730-0306

Price
$360

Features
Character appearance: 5 by 7 dot matrix; inverse video; character generator in EPROM; graphics

Software
Software in ROM, compatible with Integer and Applesoft BASIC, Apple Pascal, and the Microsoft Softcard; Apple cursor editing; supports Pascal type-ahead buffer

Hardware
Synertek 6545 LSI circuit; consumes 2.75 watts

Smarterm

Advanced Logic Systems' Smarterm board has EPROM-based control software and supports software switching of the screen between video sources. Smarterm generates characters formed from 5 by 7 dot matrices with no lowercase descenders. When used in slot 3, Smarterm supports the Pascal system and the Microsoft Softcard. Keypress and type-ahead are also maintained under Pascal.

Smarterm supports the hardware shift-key modification. Without the shift-key modification, CTRL-A capitalizes the next character when the keyboard is in the lowercase mode. CTRL-Z engages the shift-lock mode, where the keyboard will remain until CTRL-A is entered.

Smarterm has a medium-resolution graphics mode (160 elements horizontal by 72 elements vertical). (Basically, each normal character field is divided into three rows and two columns.) Smarterm can clear the screen, set the screen to black or white, plot points, draw lines, or draw a graphics character at the current cursor position. The documentation consists of a 47-page manual; no source code is given. Smarterm is now distributed by Apple Computer Inc.

Sup'R'Terminal

The Sup'R'Terminal board from M & R Enterprises has EPROM-based control software and generates characters formed from 5 by 8 dot matrices with true lowercase descenders. Sup'R'Terminal's font tables are stored in programmable memory, rather than ROM, so they can be

At a Glance

Name
Sup'R'Terminal

Use
80-column video-display interface for the Apple II or Apple II Plus

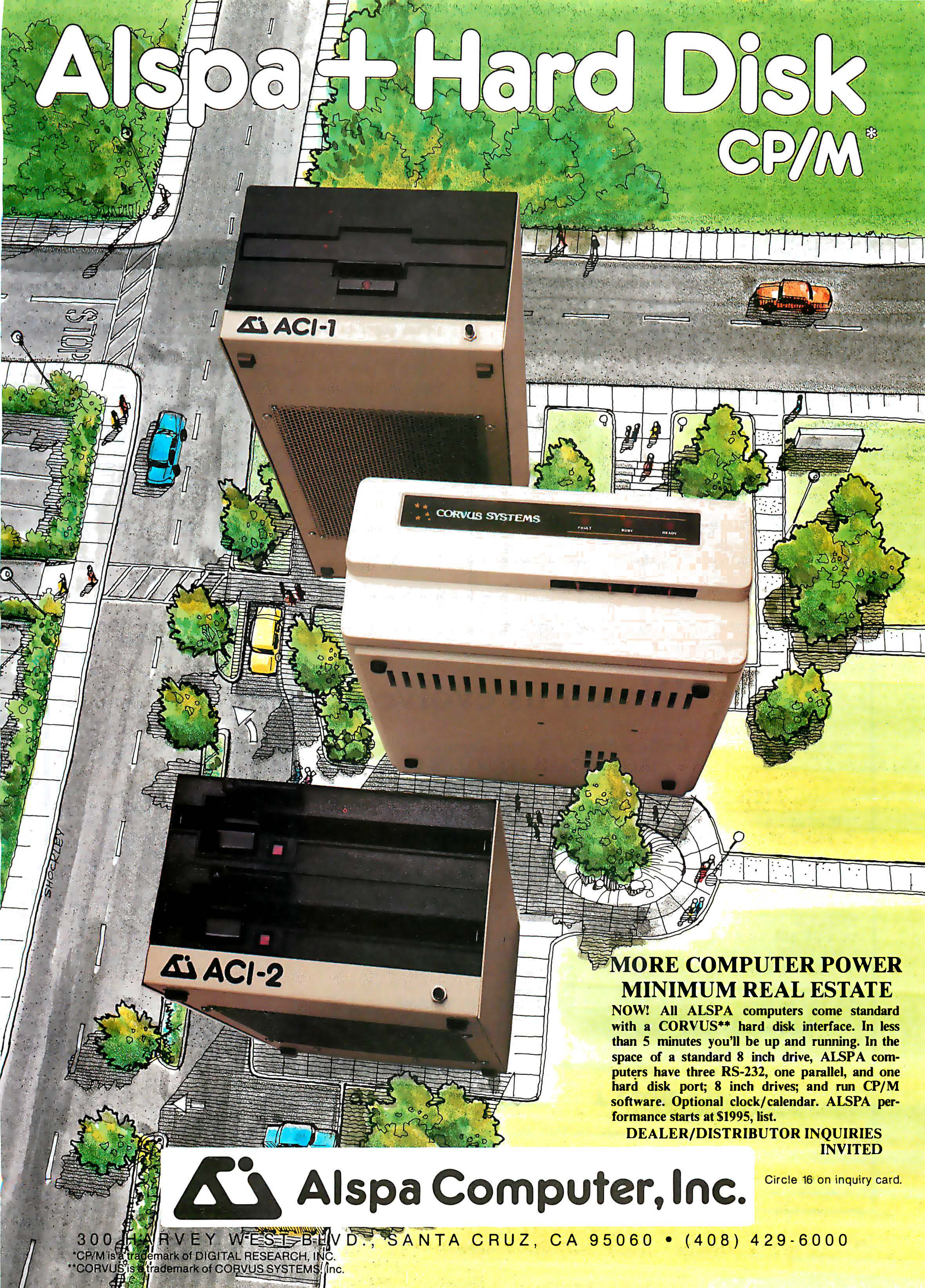
Manufacturer
M & R Enterprises
Suite E, 285 Sobrante
Sunnyvale, CA 94086
(408) 738-3772

Price
$375

Features
Character appearance: 5 by 8 dot matrix, lowercase descenders; inverse video; character generator in programmable memory; supports up to ten alternate character sets; graphics

Software
Software in ROM, compatible with Integer and Applesoft BASIC, Apple Pascal, and the Microsoft Softcard; Apple cursor editing; supports Pascal type-ahead buffer

Hardware
Motorola 6845 LSI circuit; consumes 4.5 watts



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At a Glance

Name
Videoterm

Use
80-column video-display interface for the Apple II or Apple II Plus

Manufacturer
Videx
897 Grant Ave.
Corvallis, OR 97330
(503) 758-0521

Price
$345

Features
Character appearance: 7 by 9 dot matrix, lowercase descenders; inverse video (hardwired); character generator in EPROM; supports alternate character set in EPROM (option: $39); graphics

Software
Software in ROM compatible with Integer and Applesoft BASIC, Apple Pascal, and the Microsoft Softcard; Apple cursor editing; supports Pascal type-ahead buffer

Hardware
Motorola 6845 LSI circuit; light-pen input port; consumes 2.75 watts

changed easily under program control. Up to ten alternate character fonts for languages and graphics are supported.

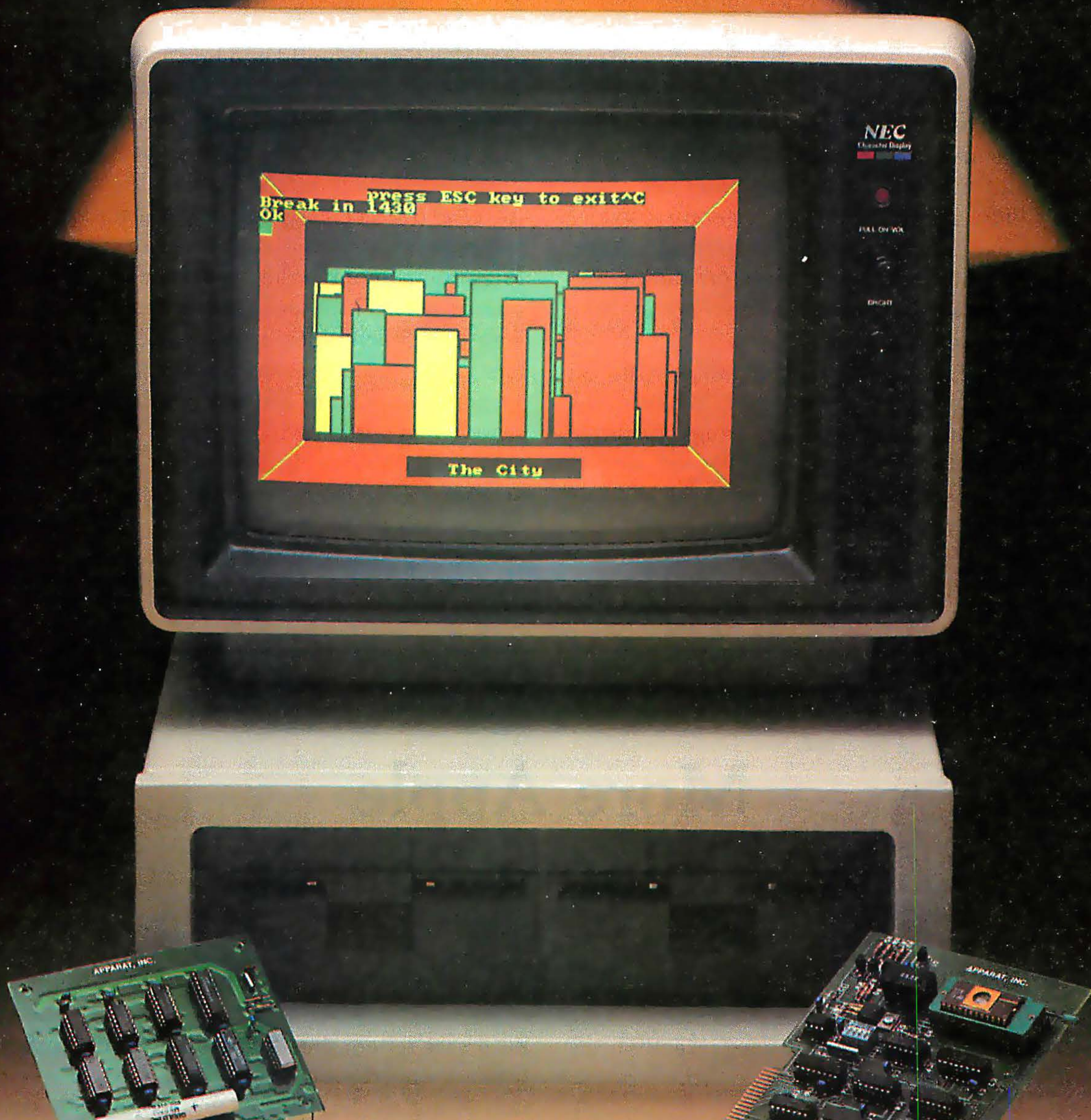
Sup'R'Terminal does not support software switching of the video display between the Apple II and its video sources. A manual video switch is not included. Sup'R'Terminal has a special video-balance circuit adjustment that improves the appearance of characters on low-resolution monitors. This circuit tends to correct the difference in intensity between vertical and horizontal lines in a character.

When used in slot 3, Sup'R'Terminal supports the Pascal system and the Microsoft Softcard. M & R Enterprises supplies the source code to provide keypress and type-ahead support for the Pascal system.

Sup'R'Terminal supports the hardware shift-key modification. Without the shift-key modification, CTRL-A capitalizes the next character when the keyboard is in lowercase mode. CTRL-A CTRL-A causes the keyboard to enter a shift-lock mode.

Sup'R'Terminal attaches to the Apple II computer in two places. The main board is inserted into a peripheral slot, while a second, smaller board, which is connected to Sup'R'Terminal by a four-wire cable, is inserted in integrated-circuit location C2. (The C2 integrated circuit must be removed from the Apple motherboard and plugged into the small board.) The documentation con-

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sists of a 29-page manual that does not contain the firmware source code but does have many sample BASIC and Pascal programs. One interesting BASIC program converts control codes for Apple II Applesoft programs to the control codes required by Sup'R'Terminal.

Videoterm

Videx's Videoterm board supports software switching of the video display as a $35 option; in addition, a manual video switch is available for $19. The board has a light-pen input and supports an optional alternate character-generator EPROM ($39) of which several are available. (A special half-intensity character generator gave particularly good results on several monitors during my tests.) Characters are generated from a 7 by 9 dot matrix, and lowercase letters have true descenders.

When used in slot 3, Videoterm is compatible with the Pascal system and the Microsoft Softcard. Without the Videx Enhancer II (which, among other things, modifies the Apple keyboard to allow the shift key to work), CTRL-A is used to toggle between the lowercase and uppercase modes. If the video-switching option is installed, the standard single-wire shift-key modification to the Apple keyboard allows Videoterm to recognize both uppercase and lowercase letters via the shift key.

The documentation consists of a 141-page manual that includes firmware source code, many programming examples, and schematics of the board.

Conclusions

Which board should you buy? Unfortunately, the decision is not an easy one because no board outshines the others when all features are considered. I recommend that you have the entire package you intend to use demonstrated, including the display board, monitor, software, and other peripherals. Failure to consider all the components as a unit could lead to additional expenditures for a monitor and software updates. The newer boards (i.e., Full-View 80 and Smarterm) feature software-controlled video-source switching. This feature offers greater user convenience because multiple monitors or manual switches are not required. Having to flip a switch, and not knowing when, can be a source of confusion for the novice. Videoterm's half-intensity character-generator EPROM offered one of the most legible character sets of all the boards tested. The final choice, of course, is yours. You will be most successful if you have your retailer demonstrate the entire system. ■

More Apple 80-Column Boards

Gregg Williams
Senior Editor

Two new Apple 80-column boards have recently been introduced. Here's a brief look at both of them.

Vision-80

Vista's Vision-80 board for the Apple (originally designed in Australia) is a very refined 80-column board. In fact, I've seen the Videoterm, Omnivision, Vision-80, Full-View 80, and Wizard-80 boards, and I'm most impressed with the Vision-80 because of the many things it does. Its two most interesting features are the retention of standard Apple commands associated with manipulating the 40-column Apple II text window and its ability to be used as an intelligent terminal.

First, the prosaic stuff. Vision-80 (see photo 1a, page 268) supports most Apple peripherals, including the Apple Pascal card and the Microsoft Softcard. Vision-80 must be placed in Apple slot number 3. Its software is in erasable programmable read-only memory (EPROM), although the source code for it is not given in the documentation. It supports a shift-key modification that allows the Apple keyboard to produce both uppercase and lowercase letters, but there is no provision for toggling between uppercase or lowercase if the shift-key modification is not made. The video monitor connected to the Vision-80 can display the 80-column screen or the standard 40-column text and low-resolution or high-resolution graphics screens under software control. The characters are formed in a large 9 by 10 grid (see photo 1b).

One of the problems with all of the 80-column boards *except* Vision-80 is that they do not respond properly to many of the text-screen manipulation commands common to many Applesoft and Integer BASIC programs. This means, for example, that when you use 80-column video board X with a given program, you may have to go into that program and replace, say, all occurrences of the HOME command with PRINT CHR$(25) because that is what board X recognizes as a command to clear the text screen and home the video cursor. Vision-80 does not respond to *all* text-screen manipulation commands used by the Apple, but it does respond to far more than any other board. The commands it responds to include HOME, TEXT, GR, HGR, HGR2, POKEs to the text-window

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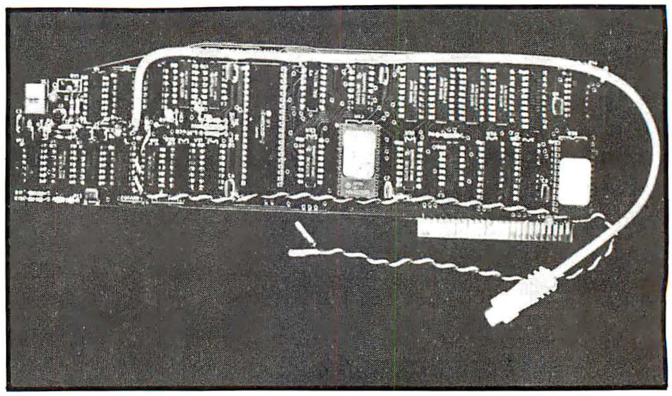
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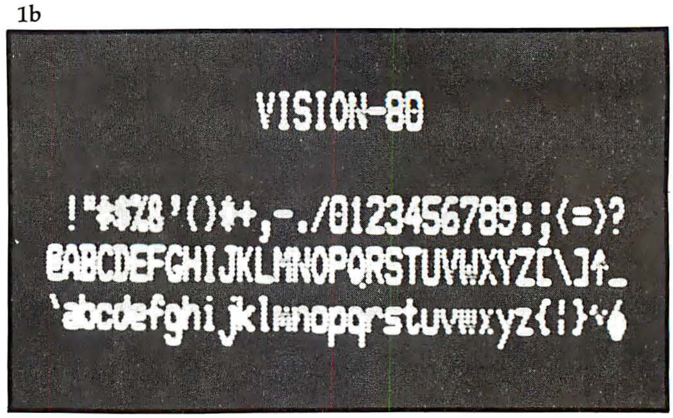
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Photo 1: *The Vision-80 board (1a) and video display (1b).*

1a



1b

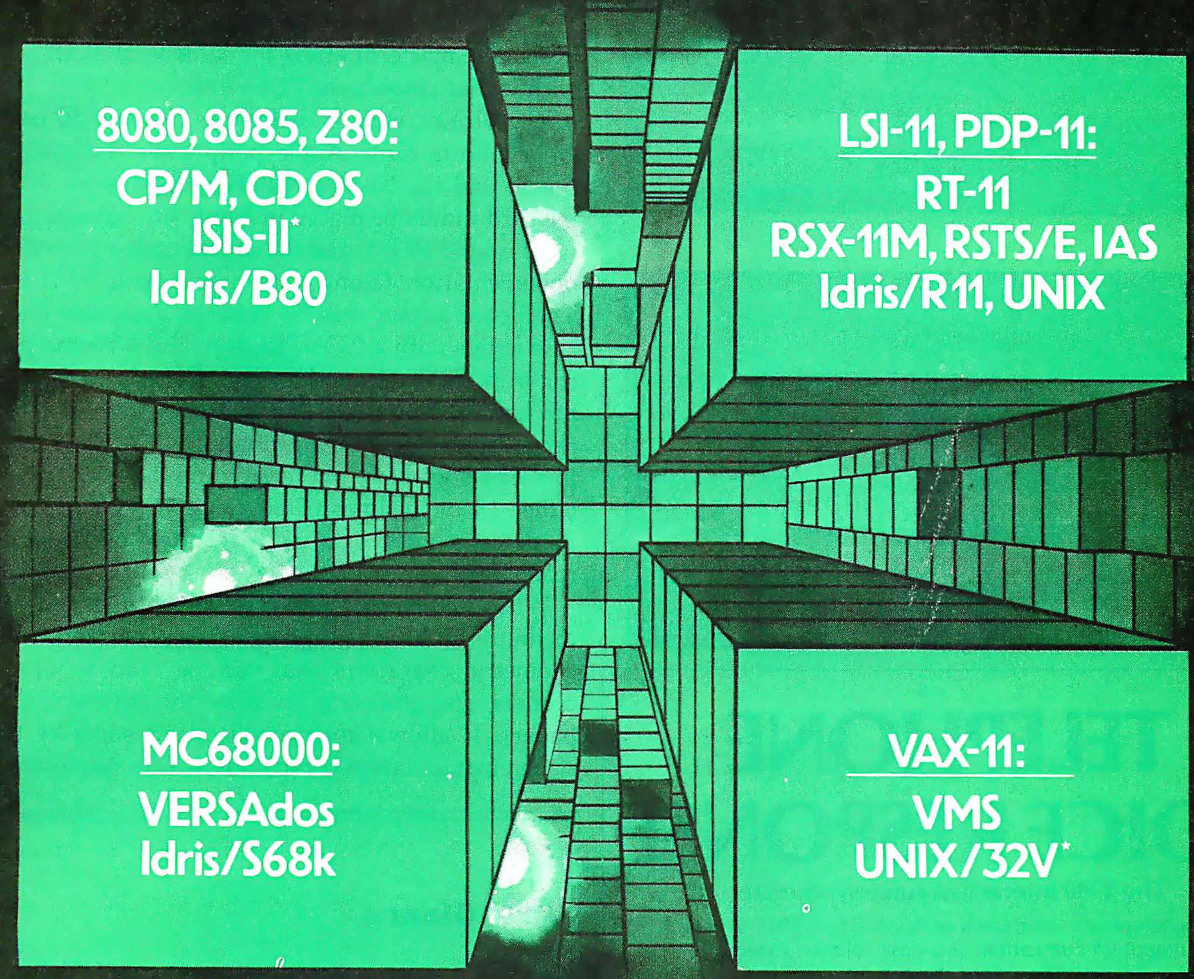


values in memory locations 32 through 35, ESCAPE SHIFT-P (same as HOME), ESCAPE E or CHR$(29) (clear to end-of-line), ESCAPE F or CHR$(11) (clear to end-of-page), TAB, HTAB, VTAB, INVERSE, NORMAL, the cursor movement and copying keys (right-arrow, left-arrow, ESCAPE A through ESCAPE D, and ESCAPE followed by I, J, K, or M), and CONTROL-S for stopping output to the video screen. In addition, you can switch between text and graphics screens under software control and you have a choice of six cursors (cursor shape can be either a block or an underline and it can be slow, fast, or no blink, a total of six combinations).

An interesting feature of the card is that it can be used with an acoustic modem and either the Apple Communications Card or the California Computer Systems Serial Card to make an intelligent terminal that can operate at data rates of up to 1800 bits per second. With a 48K-byte disk-based Apple, all available memory (about 33K bytes) can be used as a text buffer to store incoming data. Within the "communication option" (as it's called), the board can communicate with the disk operating system (DOS), which allows the saving and transmitting of files. If the remote computer is another Apple II with a Vision-80 board, your Apple can control itself and the remote Apple—potentially a powerful feature. The only thing bad that can be said about this feature is that it is not an option on the board. I'm sure it adds to the board's $395 price tag, and you may not want to pay for it if you do not need communications capabilities or if you already have them (e.g., in a Hayes Micromodem, which is incompatible with Vision-80).

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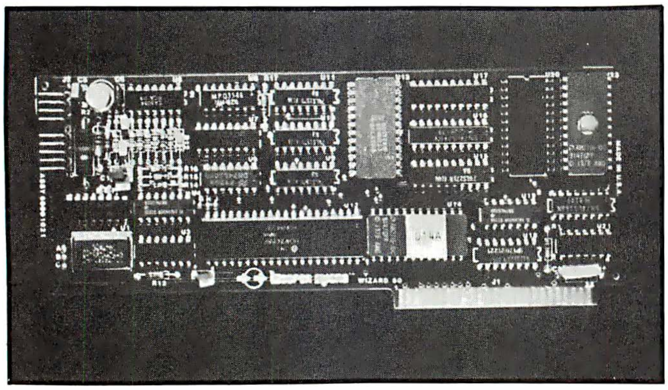
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Photo 2: *The Wizard-80 board (2a) and video display (2b).*

2a



2b



Wizard-80

Wesper Micro Systems' Wizard-80 board is an adequate 80-column board, but it has a few problems and lacks any outstanding characteristics that would distinguish it from many other Apple 80-column boards. One nice feature is the "medium-resolution" style of black-and-white pixel graphics that the board offers. Each character can be divided horizontally into three square pixels, giving a resolution of 72 rows of 80 pixels each. However, the Smarterm offers the same kind of graphics, but with higher resolution: 72 by 160.

The prosaic stuff is as follows. Wizard-80 (see photo 2a) supports most Apple peripherals, including Apple Pascal and the Microsoft Softcard; to work with them, the card should be placed in Apple slot number 3. Its software is in EPROM, and the source code is provided in the documentation (along with a schematic of the board). The board allows shifting between uppercase and lowercase letters with a CONTROL-A, but it has no provision for working from the shift key. There is no provision for mechanically or electrically switching the 40- and 80-column displays to the same monitor. Characters are formed in a 7 by 9 grid (see photo 2b), and the board can display either 18 or 24 lines of 80 characters each; the 18-line mode is a good feature that often makes text more readable.

Wizard-80 has some interesting features, including the medium-resolution graphics I mentioned and a set of 16 geometric characters that can be used to draw lines, corners, and grids (e.g., to draw the outline of a sheet of paper). It allows inverse video and some of the text-screen manipulation commands used in Applesoft and In-

At a Glance

Name
Vision-80

Use
80-column video-display interface for the Apple II or Apple Plus

Manufacturer
Vista Computer Company
1317 East Edinger
Santa Ana, CA 92705
(714) 953-0523

Price
$375

Features
Character appearance: 9 by 10 dot matrix; inverse video; character generator in EPROM

Software
Software in EPROM, compatible with Integer and Applesoft BASIC, Microsoft Softcard, and Apple Pascal; supports Apple cursor editing and most Apple screen-manipulation commands

Hardware
Hitachi HD46505 LSI circuit

At a Glance

Name
Wizard-80

Use
80-column video-display interface for the Apple II or Apple II Plus

Manufacturer
Wesper Micro Systems
14321 New Myford Rd.
Tustin, CA 92680
(714) 730-6250

Price
$295

Features
Character appearance: 7 by 9 dot matrix; inverse video; character generator in EPROM

Software
Software in EPROM, compatible with Integer and Applesoft BASIC, Microsoft Softcard, and Apple Pascal

Hardware
Uses Hitachi HD46505 LSI circuit

teger BASIC programs, including ESCAPE SHIFT-P (to clear the screen and home the cursor); ESCAPE E and ESCAPE F (or CHR$(29) and CHR$(11)) to clear to end-of-line and end-of-screen, respectively; CONTROL-S to stop video output; right-arrow, left-arrow; and ESCAPE A through ESCAPE D to control the cursor. One feature not found on some other 80-column boards is a goto-xy control code that lets you position the cursor anywhere on the screen under program control.

Two program bugs were found in the Wizard-80 board. The first is that the board does not respond to one of the two codes that are supposed to move the cursor up. The board responds to ESCAPE D (as does the unaugmented Apple II), but it doesn't respond to CONTROL-SHIFT-O (as stated in the manual). The second bug occurs when you SAVE or DELETE a command to the disk—the board does not go to the following line to receive your next command but, rather, receives it on the same line. Although the Apple does not malfunction because of this, it is a bug that is definitely there. (The board was tested on two different revisions of the Apple II to verify the validity of these bugs.)

The most serious flaw of the Wizard-80 is too many poor design decisions related to human interaction with the keyboard (which, after all, is the major way that you interact with your Apple). Of the 16 geometric shapes available from the board, four are not available from an unmodified Apple keyboard (although they are available if your Apple has one of several "extender" boards that add features to the keyboard); these shapes are available only through program control (e.g., through the CHR$ function in BASIC).

Another problem is the cursor control keys. It is to Wesper Micro Systems' credit that the board responds to the standard Apple ESCAPE A through ESCAPE D keys (each a two-keystroke sequence), but the more convenient ESCAPE followed by I, J, K, or M method was not implemented (the four letters form a diamond shape that indicates the direction of cursor movement). Wesper did implement control keys to do cursor movement, but chose CONTROL-SHIFT-O for cursor-up, CONTROL-U for cursor-right, CONTROL-J for cursor-down, and CONTROL-H for cursor-left. If you look at the relative layout of those keys on the keyboard, you'll see that they bear no relation to the cursor-movement direction. I believe that here, as in several other places, the designer was more concerned with making the board easy to implement than with making it easy to use. ■

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More Maze Building

A Pascal program to generate mazes efficiently on a printer.

Thomas Edward Neldner
2223 North Quantico St.
Arlington, VA 22205

A maze may look incredibly complex, yet it must satisfy just three simple conditions. The maze must have only one starting point and one ending point. All points in the maze must be accessible from the starting point. And there must be only one path from the start to the finish. (For a discussion of the theory behind maze building, see "How to Build a Maze," by David Matuszek, in the (December 1981 BYTE, page 190.)

This article presents a complete program, written in Pascal, to generate mazes on a printer. The program is efficient in terms of speed and memory requirements and may readily be modified to create different kinds of traditional random mazes.

To understand the program, we must first examine traditional mazes with a view toward the efficient storage of a maze within a computer. Each maze is a certain number of "cells" wide and high. A standard cell has four sides and looks like this:

```
+--+
!  !
+--+
```

Because the top and left sides of each cell are the bottom and right sides of some other cell, we consider only the bottom and right sides for our purposes here. We then consider each cell as a matrix position in matrix M. Since we are concerned with only two sides, only four different combinations of open/closed sets of cell sides are possible:

```
+ . . +   + . . +   + . . +   + . . +
.         .     !   .         .     !
+     +   +     +   +--+      +--+
   1         2         3         4
```

The dots indicate "don't care" sides of the cell.

These are the four possible combinations of openings a cell can have and are thus the four possible values a cell can achieve. We are also going to define a fifth value, that of zero or "no value." Such a cell is in a pristine or "frontier" state—it has yet to be touched by the program.

To Create a Maze

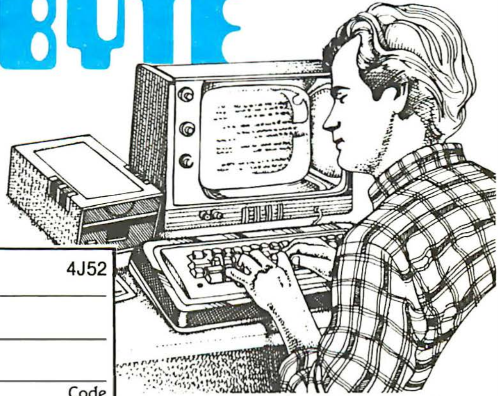
First, a starting position must be created. Since both the start and stop position are immaterial, this merely amounts to printing the word START and a line of "− − +" with one opening.

The program in listing 1 starts at an arbitrary position in the maze: the upper left cell. Note that this is not the upper left cell of the matrix; it is rather the M[1,1] cell, assuming subscripts of zero are allowed. M[0,0] would be the actual upper left cell, but this is part of the boundary described later. The program then tests the cells around it, searching for frontier cells. Since there are four directions out of any cell, there are 2^4 or 16 possible combinations of directions available, which may or may not open onto a frontier cell. The two special conditions are: it is not possible for all neighboring cells to be frontier (we had to get to this cell somehow, thus making the previous cell nonfrontier); and if it is not possible to go in any direction, the path we were creating has come to a dead end—we are stuck.

The first of the nested CASE statements in listing 1 takes one of the 14 remaining possible combinations of directions (it picks randomly) and goes in that direction, making the cell it is moving into nonfrontier. And so the program winds its way through the matrix, "cutting" a path through the frontier cells as it does so. Sooner or later that path will curl up on itself, reaching a point where there are no frontier cells surrounding it.

When this happens, that cell is vacated, and the program goes back to the arbitrary starting cell (the upper left) and once again tests for frontier cells surrounding it. If there is one, the program once again takes off, blazing a trail through the frontier until it curls up and cannot continue. Once again, the system returns to the upper left cell and tests for frontier cells surrounding it. This can happen only a maximum of twice for the upper left cell; after that the program is stuck indeed.

So the program moves one cell to the right of the upper left cell and starts all over again, testing for frontier cells around it. Once again, this can happen only twice, and thus the program continues until it reaches the right-hand end of the line. Note that this is the only case where the pro-



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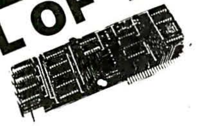
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Listing 1: *The maze-builder program, written in UCSD Pascal.*

```
{$G+}
{2/28/80}
PROGRAM MAZE;
LABEL 190,210,500;
CONST H = 10;W = 23;
VAR Q,Z,A,B,I,J,X:INTEGER;
    M:ARRAY [0..11,0..24] OF INTEGER;
    SEED:REAL;

PROCEDURE L150;BEGIN
   M[I,J]:=M[I,J]-1; J:=J+1; M[I,J]:=4; Q:=0; END;
PROCEDURE L380;BEGIN
   J:=J-1; M[I,J]:=3; Q:=0; END;
PROCEDURE L420;BEGIN
   M[I,J]:=M[I,J]-2; I:=I+1; M[I,J]:=4; Q:=0; END;
PROCEDURE L470;BEGIN
   I:=I-1; M[I,J]:=2; Q:=0; END;

PROCEDURE ONCEWITHSTYLE;BEGIN
   WRITE ('+');
   FOR J:=1 TO W DO
      IF J=X THEN WRITE ('  +')
             ELSE WRITE ('--+');
   WRITELN; END;

FUNCTION FNA(X:INTEGER):INTEGER;
BEGIN
   SEED:=SEED*27.36947+31.8723423;
   SEED:=SEED-TRUNC(SEED);
   FNA:=TRUNC(SEED*X)+1;END;

PROCEDURE GETRAND;
BEGIN;
   WRITE ('Please input a number -- any number:');
   READ(SEED); SEED:=ABS(SEED);
      REPEAT SEED:=SEED*13 UNTIL SEED>1;
      REPEAT SEED:=SEED/17 UNTIL SEED<1;
   END;

{INITIALIZATION}

BEGIN; GETRAND;
FOR I:=1 TO H DO FOR J:=1 TO W DO M[I,J]:=0;
FOR I:=0 TO W+1 DO BEGIN
   M[0,I]:=1; M[H+1,I]:=1; END;
FOR I:=0 TO H+1 DO BEGIN
   M[I,0]:=1; M[I,W+1]:=1; END;

   X:=FNA(W-2)+1;
   FOR I:=X-1 DOWNTO 1 DO WRITE ('   ');

   WRITELN ('START');
   ONCEWITHSTYLE;

I:=1; J:=1; A:=1; B:=1; Q:=0; M[I,J]:=4;

{MAIN LOOP}
```

Listing 1 continued on page 278

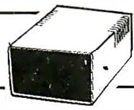
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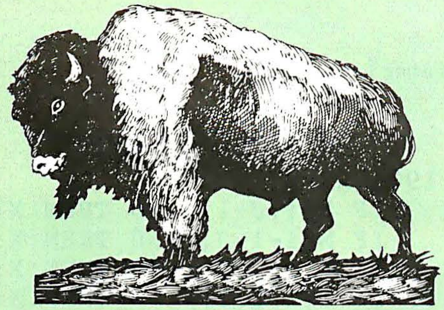
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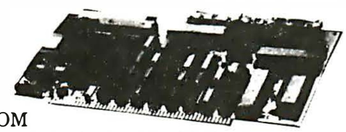
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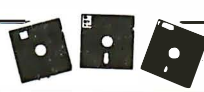
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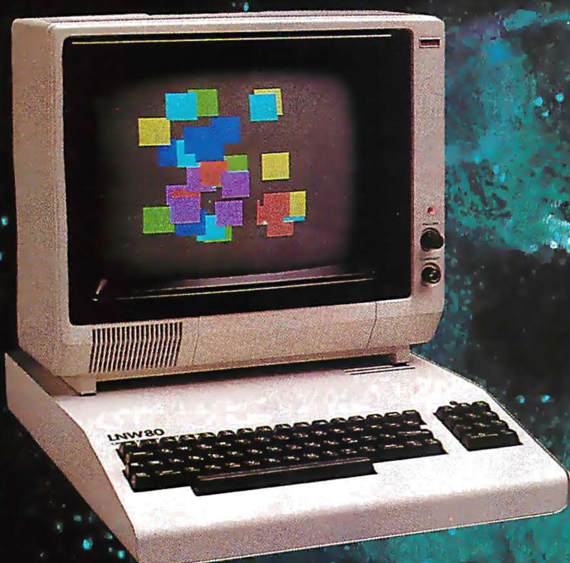
Listing 1 continued:

```
190: X:=0;
   IF M[I,J-1] <>0 THEN X:=X+8;
   IF M[I-1,J] <>0 THEN X:=X+4;
   IF M[I+1,J] <>0 THEN X:=X+2;
   IF M[I,J+1] <>0 THEN X:=X+1;

CASE X OF

   1:CASE FNA(3) OF
      1:L380;
      2:L420;
      3:L470;
     END;
   2:CASE FNA(3) OF
      1:L150;
      2:L380;
      3:L470;
     END;
   3:CASE FNA(2) OF
      1:L380;
      2:L470;
     END;
   4:CASE FNA(3) OF
      1:L150;
      2:L380;
      3:L420;
     END;
   5:CASE FNA(2) OF
      1:L380;
      2:L420;
     END;
   6:CASE FNA(2) OF
      1:L150;
      2:L380;
     END;
   7:L380;
   8:CASE FNA(3) OF
      1:L150;
      2:L420;
      3:L470;
     END;
   9:CASE FNA(2) OF
      1:L420;
      2:L470;
     END;
  10:CASE FNA(2) OF
      1:L150;
      2:L470
     END;
  11:L470;
  12:CASE FNA(2) OF
      1:L150;
      2:L420;
     END;
  13:L420;
  14:L150;
```

Listing 1 continued on page 280





Circle 239 on inquiry card.

Listing 1 continued:

```
  15:GOTO 210;
END; {OF UPPER-CASE STATEMENT}
GOTO 190;

210: IF B<>W THEN B:=B+Q ELSE
   BEGIN WRITE ('!');
      FOR J:=1 TO W DO IF (M[A,J]=2) OR (M[A,J]=4) THEN WRITE ('  !')
                                                ELSE WRITE ('   ');
      WRITELN;
      IF A=H THEN GOTO 500 ELSE
         BEGIN WRITE ('+');
            FOR J:=1 TO W DO IF M[A,J]>2 THEN WRITE ('--+')
                                      ELSE WRITE ('  +');
      WRITELN; B:=1; A:=A+1; END
      END;
I:=A; J:=B; Q:=1; GOTO 190;

500: X:=FNA(W-2)+1; M[H,X]:=M[H,X]-2; ONCEWITHSTYLE;
     FOR I:=X-1 DOWNTO 1 DO WRITE ('   '); WRITELN ('STOP');
END.
```

gram will intentionally enter a nonfrontier cell.

Now the program has finished the first line of the maze. It is no longer possible for any more work to be done to this line because there are no longer any frontier cells surrounding any cell on the line. So the system prints the top line.

Now the system moves to the leftmost cell of the second line of the maze and does exactly the same thing over again for this new line. And so the program continues, left to right, top to bottom, creating and printing the maze.

When the program has completed the maze—but before it has printed the last line—it is time to make the exit. The program randomly picks a spot on the last line of the maze and blows a hole through the bottom of the maze pattern, thus creating the stop point. The last line is printed, then the STOP message, and you have a maze with only one solution. See listings 2a and 2b on page 282 for a sample maze and its matrix.

Additional Comments

The program makes a boundary by setting the outer rows and columns of the matrix to 1, making them nonfrontier. This method wastes the outer limits of the matrix and decreases the size of the maze but is much faster than any kind of numeric subscript out-of-bounds checking since the program logic treats these outermost nonfrontier cells as off-limits territory. Therefore it won't go beyond them and cause a subscript error. Note that this requires a maze of 10 by 10 to actually be stored in a 12 by 12 matrix. Naturally, the percentage of memory required as overhead to store these outermost values goes down rapidly as the size of the maze increases, so this method becomes highly efficient with very large mazes.

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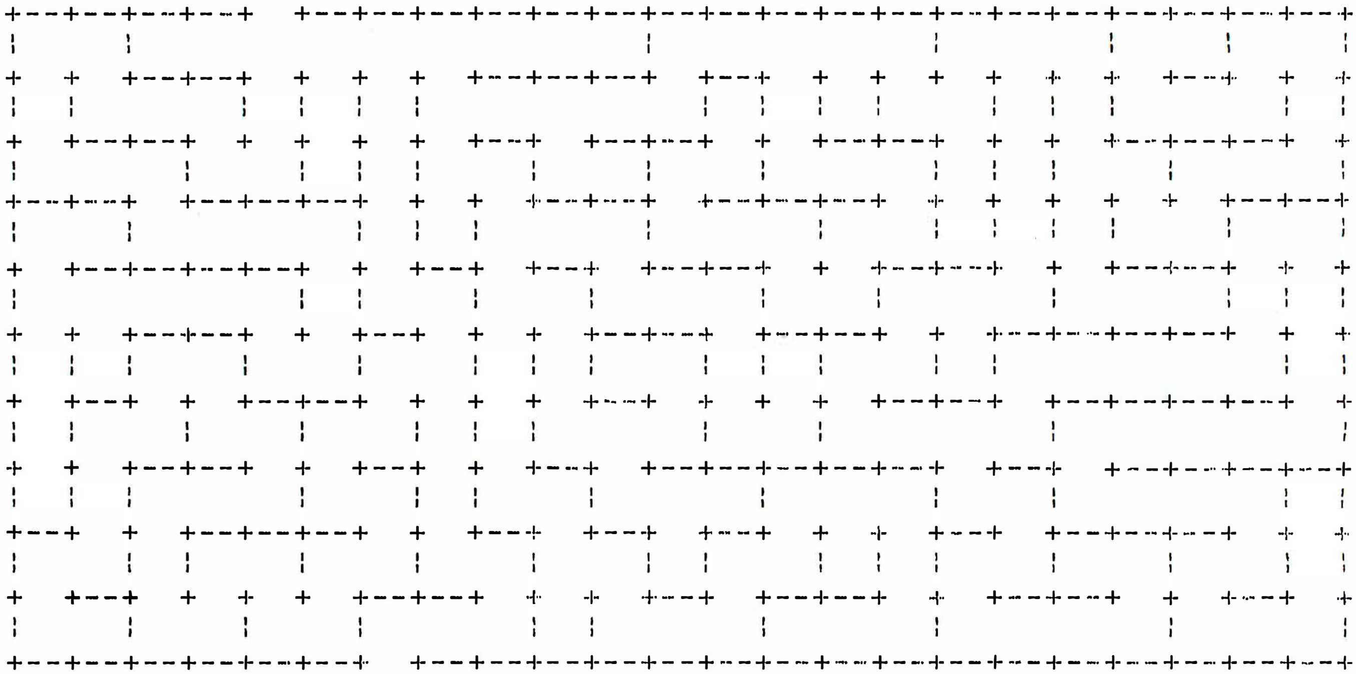
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Listing 2a: *A 10 by 23 maze. This one is rather simplistic and illustrates how the maze is easier to solve from bottom to top.*

START



STOP

Listing 2b: *The contents of matrix M, the internal representation of the maze in listing 2a. Note the outer border of all 1s. This keeps the algorithm from skipping beyond the matrix boundaries.*

```
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
1  1  2  3  3  1  1  1  1  3  3  4  1  3  1  1  2  1  1  2  1  4  1  2  1
1  2  3  3  2  2  2  2  1  3  1  3  4  2  2  4  3  2  2  2  3  3  4  2  1
1  3  3  2  3  4  4  2  1  2  3  4  1  4  3  3  2  2  2  1  2  1  3  4  1
1  1  4  3  3  3  2  2  4  1  3  2  3  3  2  1  4  4  2  2  3  4  1  2  1
1  1  1  3  3  2  2  3  2  1  2  3  3  2  3  4  1  1  4  3  3  4  2  2  1
1  2  4  1  2  3  4  1  2  2  2  3  2  2  2  1  4  4  1  3  3  3  4  2  1
1  2  1  4  3  2  1  4  2  2  3  1  4  3  4  3  3  1  4  1  3  3  3  4  1
1  4  2  1  3  4  3  2  2  3  2  3  1  4  1  1  2  3  2  3  3  3  2  2  1
1  1  4  2  1  2  1  4  3  2  1  2  4  1  4  4  2  1  4  3  2  1  4  2  1
1  3  4  3  4  3  4  1  3  4  4  3  3  4  3  3  4  3  3  3  4  3  3  4  1
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
```

Q is a Boolean variable that is also used as an arithmetic argument. The value of Q decides whether we advance to the next cell of a line (Q = 1) or not (Q = 0).

The program is very simple. Since it requires only integer arithmetic and uses a maximum integer value of 15, it is a rather trivial task to convert to machine language. Since each maze cell can attain only five values, this means that on a 60K-byte computer, assuming 4K bytes are used for program and operating system, and assuming each byte is broken into two cells, a maze

$$\sqrt{(60000 \times 2)} \text{ or } 340$$

cells square is possible. Since a 132-column printer can print only 43 cells across, this means a 2500 by 43 maze can be created. Assuming 66 lines per page, a maze almost 80 pages long is possible.

The algorithm is fast. There is almost no delay between successive lines of the maze on my line printer past the first few (I use a Horizon computer at 4 MHz with an Anadex printer).

Possible Enhancements

One side effect of the algorithm is that the maze is almost always easier to solve by traveling from bottom to top. This makes sense when you realize that there are more possible pathways for the maze maker when the maze is "young" than when it is "older" (farther down, or more complete). Pathways created will generally be longer near the top of the maze and will have more possible paths diverging from them. A nifty solution to this problem is to duplicate the same algorithm in reverse, starting from the bottom right cell and moving from right to left, bottom to top. However, if the program figures out one line at the top, then one line at the bottom, alternating, the maze will be impossible to solve since the two separate pathways will never intersect. To fix this problem, randomly pick one place where the two pathways run side by side and cut a wall to connect them at that point. Naturally the correct solution of the maze will run through that hole.

Another option to make the mazes more difficult is to weigh the random-number generator in favor of paths that extend vertically—at least for the first several thousand decisions (this is assuming the maze is higher than it is wide, which will normally be the case). Other "derandomizing" operations on the random-number generator output can create beautiful and eye-catching patterns, not to mention some eye-strainers.

After each line of the maze is printed, the corresponding matrix row is never used again. It is possible at that time to shift the entire matrix up one row. The first line disappears, the second becomes the first, the third line becomes the second, and so on through the end of the matrix. Be careful to set the last line to frontier status. The program then becomes capable of making *infinite* length mazes having only a single solution. Implementation of this feature is left to the motivated reader. ■

Colne Robotics Armdroid

The Small-Systems Robot

Steven W. Leininger
5402 Summit Ridge Trail
Arlington, TX 76017

If you think you've explored all the possible hardware options for your small-computer system and are looking for some excitement, you might be interested in Armdroid, a new computer-controlled robot arm. The bright orange mechanical arm is available from Colne Robotics in kit or assembled form, complete with power supply and interface electronics. The kit form, besides being less expensive, "enables the person assembling the device to understand the principles of the robot," according to the manufacturer. The robot can be used for a variety of experimental and educational applications. It has 6 degrees of motion and a lift capacity of 10 ounces. I received both a kit and an assembled Armdroid for my evaluation, along with a "preliminary" manual.

Mechanical Description

The Armdroid has five major mechanical components: the base, the shoulder, the upper arm, the forearm, and the wrist and hand assembly. Each section is connected to its neighbor by a pivoting or rotating joint. The stationary base sits on the tabletop and provides support for the rest of the arm. The base, which also serves as the enclosure for the stepper-motor-drive electronics, contains the motor which rotates the arm about a vertical axis through the base.

About the Author

Steven W. Leininger was the design engineer for the original Radio Shack TRS-80 Model I microcomputer. He is now an independent computer consultant.

At a Glance

Name
Armdroid

Use
Robotic arm

Manufacturer
Colne Robotics
207 NE 33rd St.
Fort Lauderdale, FL 33334

Dimensions
At shoulder: 18 by 18 by 29 cm (7 by 7 by 11.5 in)
Shoulder pivot height: 25 cm (10 in)
Arm length at maximum extension from shoulder pivot to finger tip: 48 cm (19 in)

Price
Kit: $595
Assembled: $695

Features
6 degrees of motion; menu-driven control software; 10-ounce load capacity

Additional Hardware Needed
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Additional Software Needed
Learn, an interactive menu-driven control program (included)

Hardware Option
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Documentation
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Audience
Experimenters, students, and professionals interested in robotics

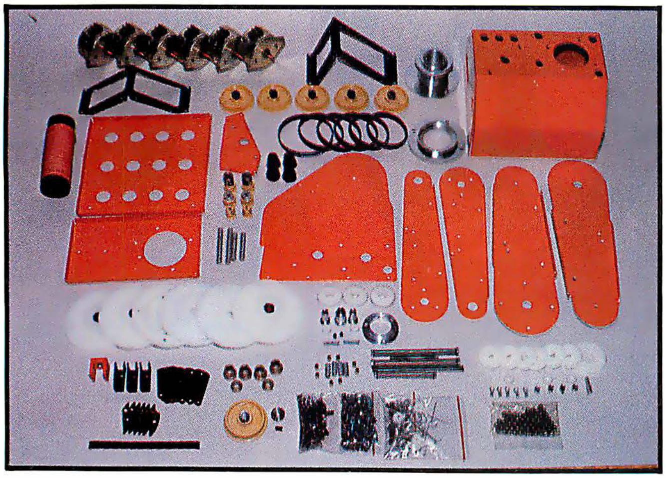


Photo 1: *The Armdroid kit's many parts. The cost of the six stepper motors (at the top of the photo) is offset by the relatively inexpensive stamped-steel chassis and structural parts. The power supply and interface electronics are not shown.*

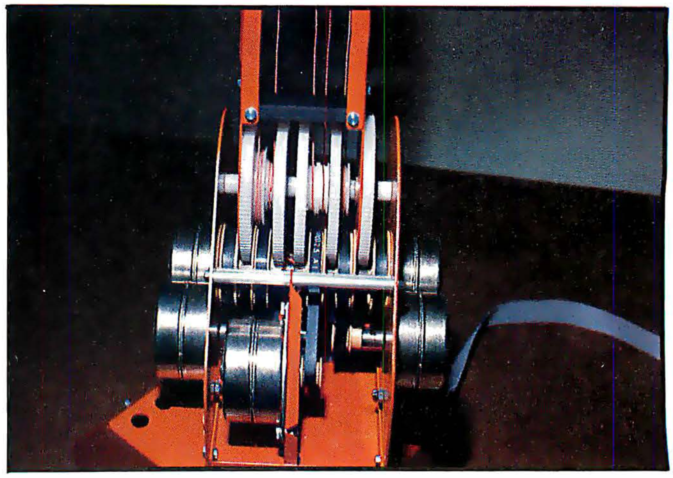


Photo 2: *The shoulder contains five of the six stepper motors. Reduction gears are used to increase the force applied via the drive cables.*

The shoulder rotates on the main bearing, a fairly heavy-duty ball-bearing assembly at the top of the base. Five stepper motors and associated reduction gears and drive belts are mounted on the shoulder and provide motion control to the arm, wrist, and hand.

The upper arm connects to the shoulder with a horizontal pivot and is rotated on that pivot by one of the stepper motors in the shoulder. If you move the upper arm vertically, the hand is raised and brought closer to the base. Cable-driving gears transmit motion to the forearm and the hand and wrist assembly; these are mounted in the shoulder end of the upper arm.

The forearm fastens to the upper arm with a horizontal pivot and is rotated about that point with one of the motors in the shoulder. The primary response to pivoting the forearm is the raising or lowering of the hand with respect to the tabletop.

The hand and wrist assembly attaches to the end of the forearm with a combination horizontal pivot and bevel gear assembly. The operator uses two motors in the shoulder to either rotate the hand about the pivot (an up-and-down motion) or twist the hand about its axis. The remaining motor in the shoulder opens and closes the hand's three rubber-tipped metal fingers.

You can move any section independently without affecting the orientation of the other sections because of the Armdroid's parallelogram-type construction. This independence of control permits the angle of the hand to remain constant with respect to the workbench while the rest of the arm is manipulated to position the hand in the desired location.

Interface Electronics

The Armdroid I tested came with an I/O (input/output) adapter for the Radio Shack TRS-80 Model I. This adapter, a nonlatched parallel port, plugs into the expansion port on the TRS-80. A cable from the adapter plugs into the base of the Armdroid.

Colne Robotics has mounted two printed-circuit cards within the base of the Armdroid: the interface board and the motor-drive board. The interface board accepts signals from the TRS-80, conditions them, and converts them to pulses of the duration and shape suitable for controlling the arm's motors. The motor-drive board amplifies the signals to provide the voltage and current levels required to drive the motors' coils.

You can set the Armdroid's internal electronics for external computer control or operation via manual switches by making the selection on the two printed-circuit boards inside the Armdroid's base.

Building the Kit

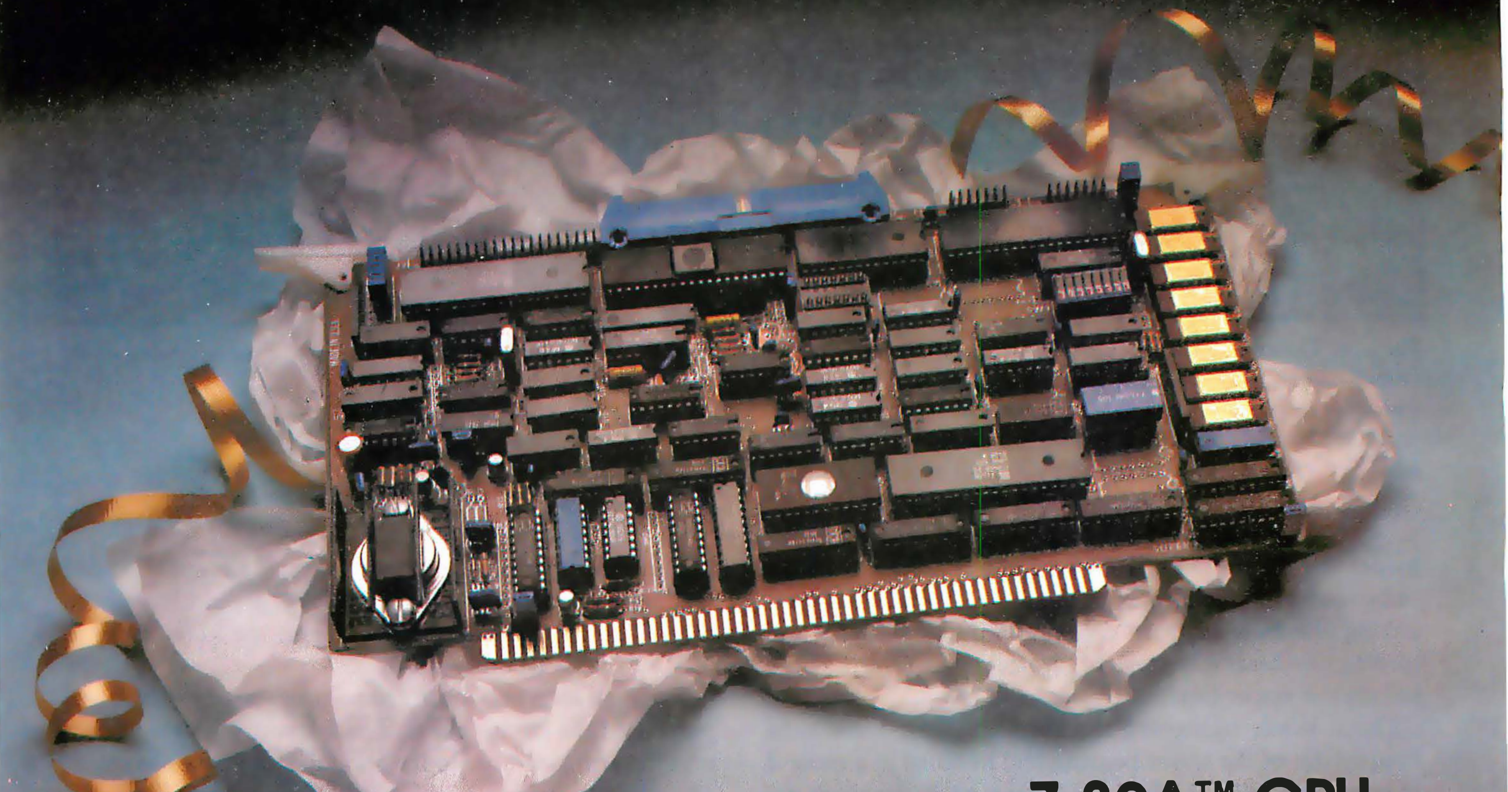
Being a disciple of Erector Set and Heathkit, I had no fears about venturing out into the frontiers of robot *kit* building. To get a feel for the scope of the project, I laid all the parts out and familiarized myself with the construction section of the manual.

The manual I received was a preliminary version. The entire mechanical assembly instructions were on just six pages! Undaunted, I forged ahead. About halfway through the first paragraph, I was instructed to glue magnets onto some of the gears. Apparently, the magnets are optional (at least they weren't included in the kit), but no mention was made of that fact. The system uses the magnets and their respective reed switches to sense the home position of the gears.

The instructions rambled on, sometimes with several steps in a sentence. The manual specified part numbers (usually) but didn't refer to the drawing numbers.

I knew the next part was going to be tricky because the instructions said that an assistant would be helpful. The task at hand was to assemble a dual-race ball-bearing assembly from scratch. Using refrigerated petroleum jelly

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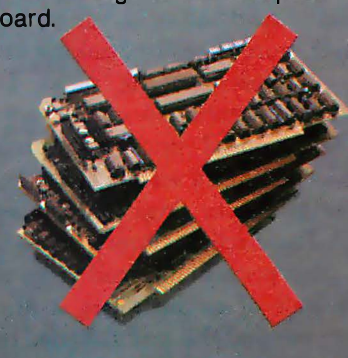
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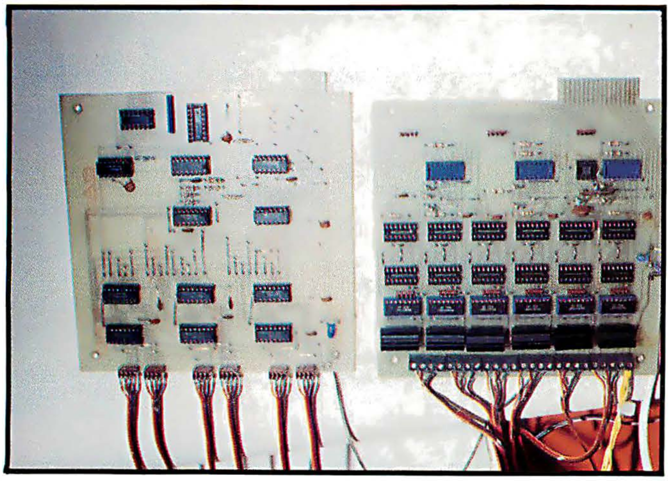


Photo 3: *The controlling circuitry is contained on two printed-circuit boards. The motor-drive board (left) and the microprocessor interface board (right) are easy to assemble and connect directly to a TRS-80 Model I (versions for the Commodore PET, the Apple II, and the Sinclair ZX81 are planned).*

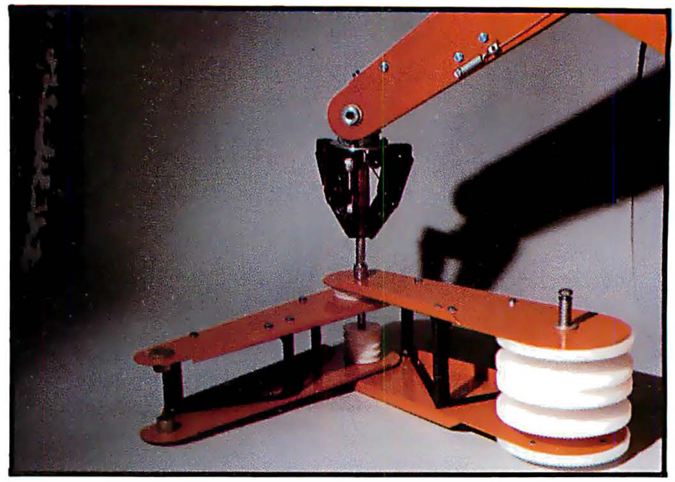


Photo 4: *A mechanical assistant can speed the assembly of the arm.*

as per the instructions, I greased the bearing track and imbedded 24 ball bearings in the goo. After carefully inserting the base-support column into the bearing and turning the assembly upright, I attempted to repeat the job on the upper bearing track.

Darn. While tightening the adjusting ring, three balls hopped out of the lower bearing and huddled in a mound of petroleum jelly. Back to the beginning; twice more the same thing happened. Arrgh!! Finally, success! But wait, why was the shoulder pan rubbing on the shoulder-drive gear? And, wasn't that ball-bearing assembly just a little bit off parallel? At this point, I decided to cheat and look at the factory-assembled Armdroid. It appeared that the bearing-support column was too short. I described my problem to the gentlemen at Colne Robotics over the phone and was told that I probably had the bearing ring—an almost but not quite symmetrical part—on upside down.

I tried it again: I disassembled the bearing, inverted the bearing ring, and carefully placed the steel balls in the petroleum-jelly-coated track (I'm pretty good at this by now). Continuing as before, I installed the adjusting ring and beheld a smoothly operating shoulder bearing.

The instructions continued: put this motor here, put these gears there, and see the drawing. Well, I looked at the drawing. (The drawings are good up to a point, but they lack fine detail or close-ups in some areas.) I cheated a couple more times by looking at the assembled arm to verify my understanding of the drawings and text.

Assembly continued on the upper arm and forearm. The wrist posed no major problems. Then disaster struck! The fingers are held together with a large number of "circlips" (split rings that fit around the outside of a shaft). The circlips allow you to slide a rod through a hole, then prevent the rod from sliding back again. A special pair of circlip pliers is an absolute necessity to proceed beyond this point. I tried to make do with what I had (needle-nose pliers, screwdrivers, etc.) and realized I definitely needed the proper tools. It would have been nice if the appropriate pliers came in the kit or were at least available as an option.

The final assembly of the hand progressed easily after I purchased the circlip pliers. The instructions said to connect the arm assembly to the shoulder and base assembly. The cable threading came next. In the helpful hints section, the instructions said that this operation is greatly simplified by threading the arm before attaching it to the shoulder. So I started over again.

The actual cable threading progressed well, except for a clearance problem on one of the wrist cables. After checking the preassembled arm, I decided that cable clearance in the wrist is an assembly problem that Colne Robotics had experienced and corrected but had not updated in the manual. Ten minutes later, the offending cable had been restrung and worked smoothly.

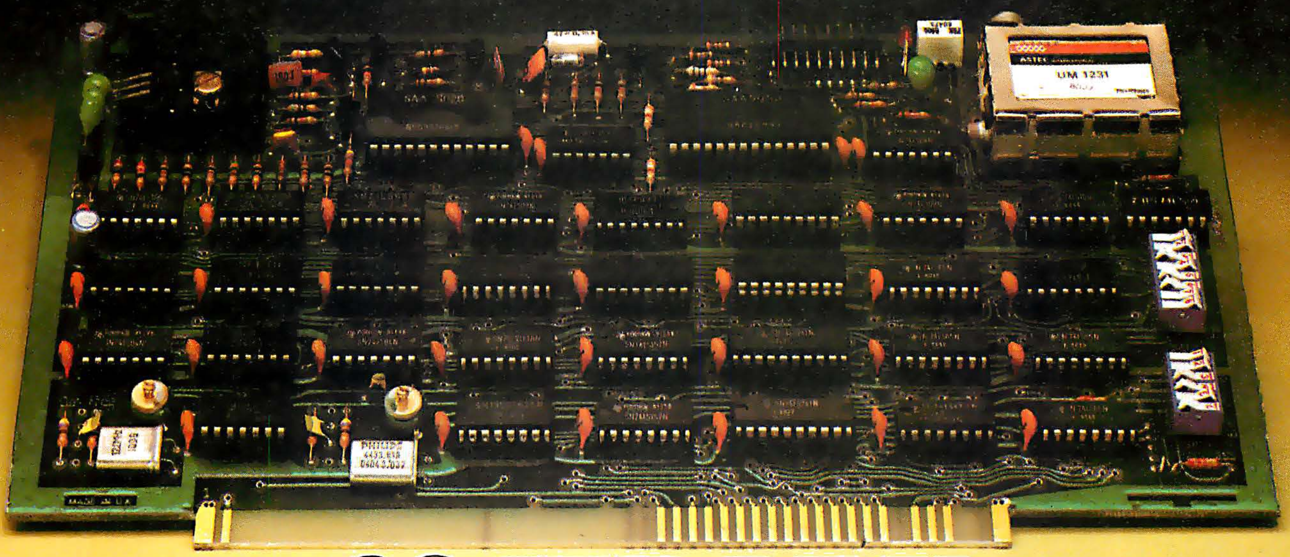
The two printed-circuit boards went together just about as well as one would expect. No part numbers or reference designators were silk-screened on the boards, so I had to rely on the drawings in the manual for parts placement. Mounting the interface and motor-driver printed-circuit boards into the base of the Armdroid and connecting the stepper-motor wires to the driver board completed the assembly operation.

Using the Armdroid

A machine-language cassette for the TRS-80 Model I Level II microcomputer comes with the Armdroid. The menu-driven program, named Learn, allows you to familiarize yourself with the operation of the robot arm and to create, modify, and save motion sequences.

The manual suggests reading through the software description quickly and proceeding to the "Introductory Demonstration Sequence" section, which tells you to load Learn and enter the learn mode by typing an "L".

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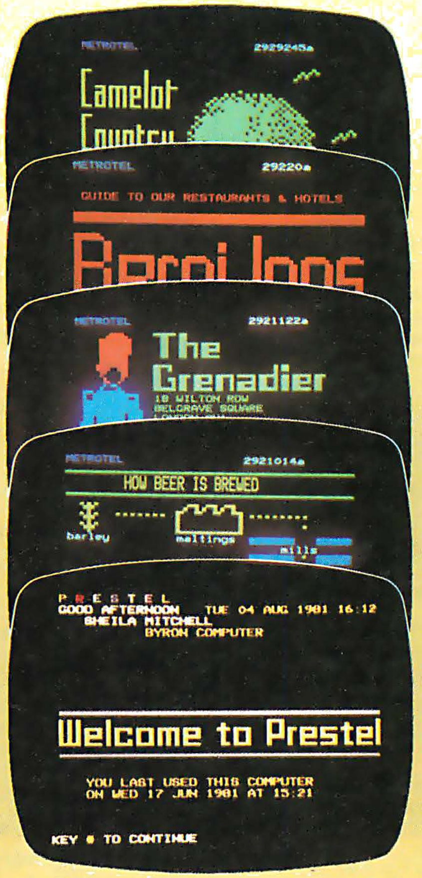
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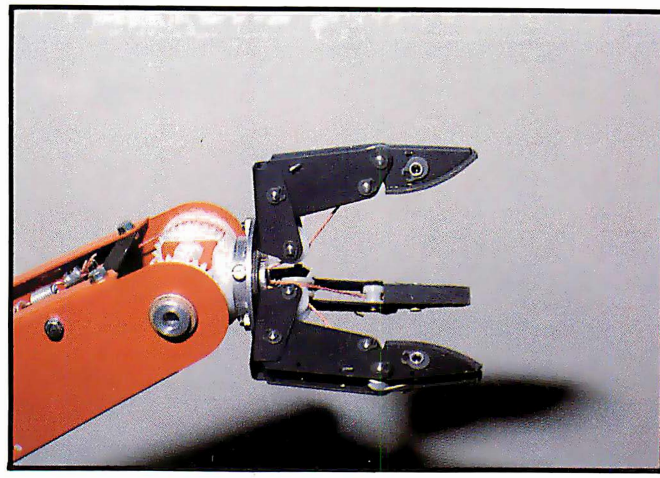


Photo 5: *The hand and wrist assembly has three fingers. The fingers are opened and closed in unison under program control. The wrist allows both rotation and up-and-down motion of the hand.*

This mode lets you manually operate the robot while programming it to follow the same motions automatically.

The program asks you if you want to start again, continue from the present position, or exit the program. Type "S" to clear the memory and free the arm. The arm is free when no torque is applied to the stepper motors. This allows you to initialize the Armdroid's position by hand using the large gears in the shoulder. When you are satisfied with the starting position, press the space bar. The program applies torque to the arm, effectively stiffening and locking the arm in place.

You can now move the arm using the Q, W, E, R, T, Y, and 1 through 6 keys to manually control the movement of the different parts of the arm. If you're like me, it will take a couple of tries to predictably move the arm, rotate the wrist, and open and close the hand under manual control. Type a "0" to get out of the learn mode.

Now the miracle of life! Press "G" for go, and the Armdroid takes the shortest path to your initial starting position. The program then asks "O" (once) or "F" (forever). Forever seems like a long time for something you haven't tried yet, so type "O".

Wow! The arm is doing just what you taught it to do! And without the long pauses for head scratching and note taking! You are returned to the menu.

To look at the sequence of commands that were sent to the stepper motors, type "D" for display. A table appears on the screen showing the stepper increment values stored in memory.

To extend the sequence of movements, simply reenter the learn mode, and type "C" for continue. You can add additional motions by using the manual-control keys. Once again, you must type "0" to return to the menu mode.

After testing the new sequence, you may decide that some of the motions need to be fine tuned. This can be done using the edit mode.

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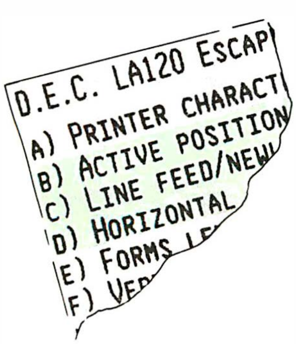


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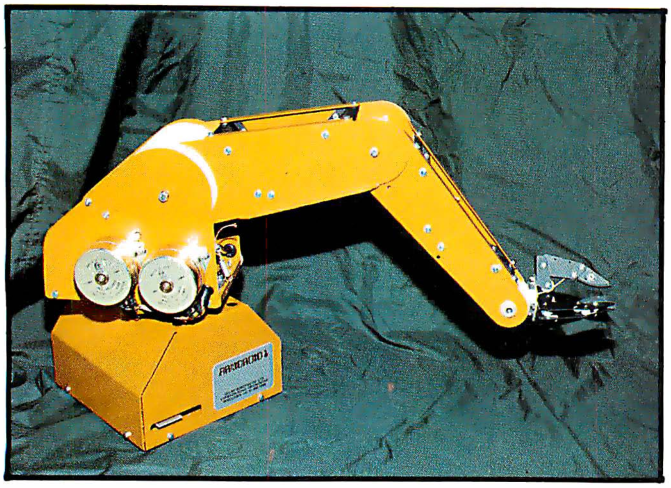


Photo 6: *The Armdroid has a maximum reach of 19 inches from the shoulder base.*

Three cassette-tape commands allow you to save your Armdroid sequence for a rainy day. "W" (write) saves the sequence in memory on the tape, "R" (read) retrieves the sequence from tape, and "C" (check) verifies that the data on the tape is the same as that in memory.

Colne Robotics has graciously included the source listing for the Armdroid control software in the manual. The Z80 assembly-language source is well documented and should prove to be a valuable learning tool for the student of robot technology. The source code is also useful to those who wish to modify the control software for a specific application.

I understand that Colne Robotics is developing similar software for other microcomputers, such as the Commodore PET, the Apple II, and the Sinclair ZX81. Watch their advertisements for further details.

Documentation

The 87-page manual is broken down into four sections. The introduction section is nine pages long and strays from the purpose of an experimental robot arm. Discussions on the economic and social impact of industrial robots, complete with tables and formulas, seem more like padding than useful information.

The second section deals with the mechanical assembly of the Armdroid. As noted above, some deficiencies and inaccuracies in the instructions exist. A hand-holding, step-by-step approach would benefit the novice builder.

The next section details the electronics of the Armdroid. This section was not too bad, but again a step-by-step approach would be helpful.

The final section describes the software package included with the arm. This chapter of the manual was the easiest to use, due in part to the quality of the Learn program itself. And I applaud the inclusion of the program listing as an aid to understanding the ins and outs of microprocessor-controlled robotics.

It should be noted that my review is based on a "preliminary" manual for the Armdroid. I have been reassured that the manual will be revised to eliminate some of the limitations that I have noted above.

Conclusions

- The Armdroid is a low-cost manipulator with good dexterity and maneuverability.
- The software delivered with the arm is easy to use and serves as a powerful tool in understanding robot operation.
- The Armdroid kit is not for the inexperienced builder, unless the manual is improved.
- I feel I have learned a lot about the mechanics, electronics, and software of robots, thanks to the people at Colne Robotics. ■

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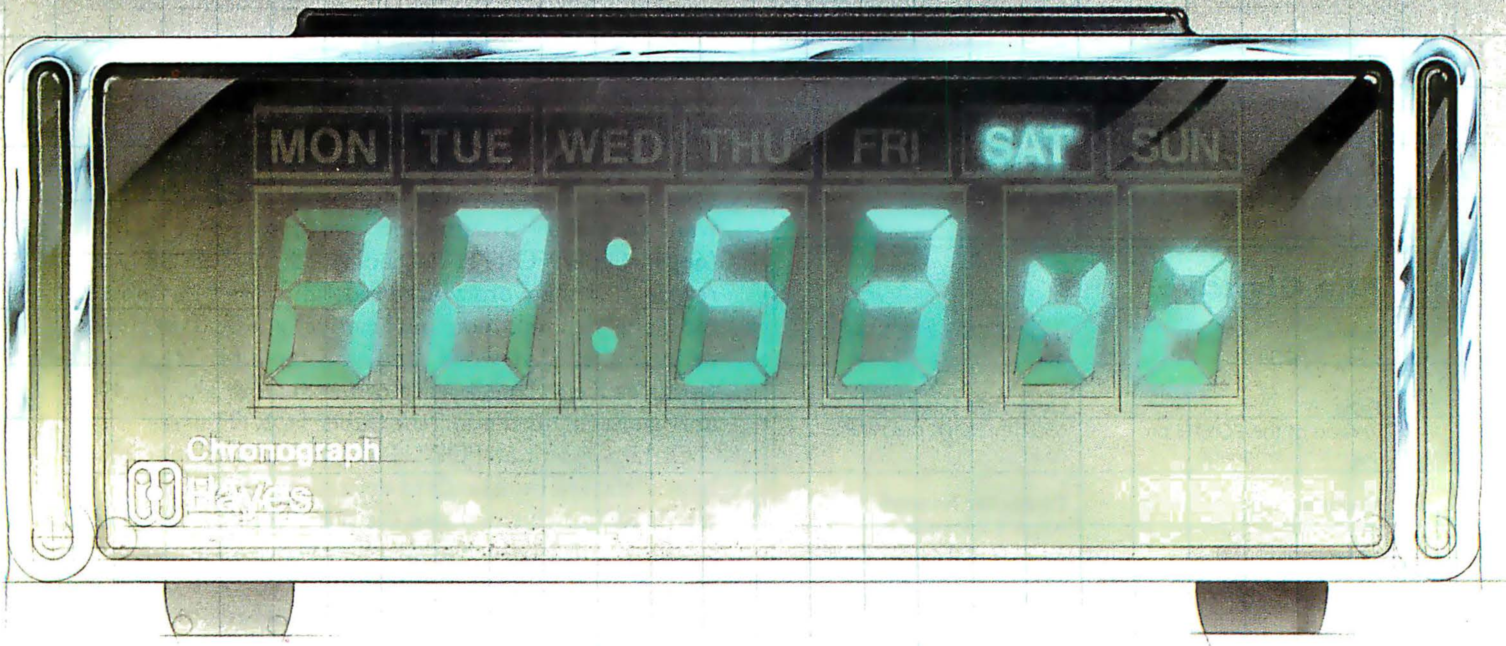
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Super FORTH Isn't

Gregg Williams
Senior Editor

Let's imagine that someone has just implemented a language that looks something like BASIC, but that it has some very strange and arbitrary qualities. For example, not every line has to have a number, but all line numbers must end with a 5. All variables must be exactly three characters long. The BASIC keyword STEP is replaced by the word EVERY, and variables used in an INPUT statement must begin with the letter I. Although the language works—you can write programs in it—how would you feel if the manufacturer called the product Super BASIC?

It's apparent that I'm very disappointed with Hayden's Super FORTH and that I don't believe it is a worthwhile product. When I first saw the ads, I was very excited about the product. It ran on the Apple (only one very expensive Apple FORTH existed at the time); it implemented Apple high-resolution graphics, floating-point numbers, and string variables (none of which are usually supplied in a standard FORTH); and the $49.95 price was right. At the time, I thought Super FORTH might become the de facto standard for the Apple II.

At a Glance

Name
Super FORTH

Type
Version of the FORTH programming language

Manufacturer
Hayden Book Company Inc.
50 Essex St.
Rochelle Park, NJ 07662
(201) 843-0550

Price
$49.95

Author
Larry Bugbee

Format
5¼-inch floppy disk (boots under DOS 3.2 or BASIC's disk)

Language Used
6502 threaded machine code

Computer Needed
Apple II with 48K bytes of memory and Applesoft either in ROM or loaded into the Apple Language Card

Documentation
35 pages in a 3-ring binder

Audience
People interested in FORTH

I have been working with different versions of FORTH for about a year and a half and have used versions based both on and independent of the FORTH Interest Group (fig) version. I say this to indicate that I can be fair with a non-fig-FORTH implementation. I spent several nights programming on the Super FORTH system, and my conclusion is this: if you want to use this particular version of FORTH because of the features mentioned above, fine. However, if you're interested in interacting with the world of FORTH outside the confines of the Super FORTH instruction manual, you should buy a different version.

Problems

To indicate why I formed my opinion of this software, here are some of the problems I found.

Super FORTH lacks the "screen" mechanism almost universally used to store FORTH source code for later compilation. It has only two commands that let you store either the entire contents of the FORTH system at that time or only newly defined words. This means that if you want to modify a definition, you have to FORGET it (oops—Super FORTH has no word for FORGET) and retype it. If the word you're redefining isn't the most recent one defined, you automatically lose every word defined after that word, and you have to retype those words as well. The absence of this feature alone puts an unreasonable burden on the Super FORTH user.

Certain essential FORTH words are missing; others have arbitrary nonstandard definitions. For example, the words ROT (which rotates the top three numbers on the stack), { +! } (which adds a number to a variable), and FORGET are missing in Super FORTH. (The braces are standard BYTE notation for FORTH words that include punctuation and for lists of FORTH words.) In addition, other words behave differently. The word C@ in other FORTHs takes the contents of a single byte and puts the byte on top of the FORTH stack; in Super FORTH, the corresponding word 1@ must be followed (don't ask me why) by the words { 0PUSH SWITCH } to make the number available on the top of the stack.



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Another arbitrary difference is that do-loops in Super FORTH cannot be nested in the same word (contrary to the way all other versions I know of work). In Super FORTH, you must define a word that contains the inner do-loop, then use this word within the do-loop of another word. Again, this is a problem only if you plan to interact with the rest of the FORTH world. Unfortunately, Super FORTH has too many such problems.

Although the Super FORTH system worked most of the time, it "went away" (irretrievably malfunctioned) many more times than my two other versions of FORTH. I counted four fatal malfunctions in one session.

Many FORTH functions, given the same name in every other FORTH implementation, are given other names in Super FORTH. For example, the FORTH words { C@ C! C, } are in Super FORTH { 1@ 1! 1, }. This small point is annoying when trying to relate Super FORTH to other written material about the FORTH language.

Another annoying point is that all numbers printed from the stack are always printed with leading zeros (e.g., 0005 if you are in hexadecimal mode, or 00005 if you are in decimal mode). Although this would be useful in printing tabular material, I think the fixed display width indicates a lack of craftsmanship.

Good Points

To be fair to Super FORTH and its author Larry Bugbee, the product does contain a number of things that are quite good.

The documentation for Super FORTH is better than average when compared to other FORTH products. Word definitions are grouped by function and are explained with a minimum of jargon. In a radical departure from most FORTH documentation, most word definitions include an example of their use, and some even give guidance for their proper use.

Super FORTH includes words that allow you to do Apple high-resolution graphics on high-resolution page 1. It allows you to draw boxes, blocks (filled-in boxes), points, lines, and shapes in any available high-resolution color. You can draw shapes, but the XDRAW function is not supported. You must have Applesoft in ROM or in a Language Card for these commands to work. (The bulk of Super FORTH will work without Applesoft.)

Another set of words implements a stack for floating-point numbers and operations. (The regular FORTH stack works on 16-bit signed integers only.) The list of floating-point words is quite long and comprehensive, making it probably the best feature of Super FORTH. These words also require Applesoft to work.

Super FORTH includes a set of words that allows you to manipulate character strings. The words do the following operations: creation of string variables, string constants, and a string stack; string concatenation; string assignment; and substring manipulation through a MID$ word.

Finally, Super FORTH includes some words that allow you to directly manipulate the FORTH environment. Little guidance on how to do so is given, but this is usually the case with most FORTHs. These words are meant for use only by veteran FORTH programmers, and it is good they are there. For example, it should be possible to use them to make a call to the Applesoft ROM to implement the high-resolution XDRAW function.

Conclusions

The inability to store FORTH source code for later modification and recompilation is a major defect of Super FORTH.

On the other hand, the implementation of string, floating-point, and high-resolution graphics words is a definite advantage for someone who wants to use FORTH with these capabilities. They can be added to other FORTHs, but this would be a lot of work in itself.

Unfortunately, I cannot recommend Super FORTH to people interested in learning FORTH. The many differences between it and the two leading versions of FORTH (those supported by FORTH Inc. and the FORTH Interest Group) would make it difficult for the user to learn from the existing body of information on FORTH. It could be done, but it would require a lot of extra work.■



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Book Review

Fifty BASIC Exercises

Jean-Pierre Lamoitier
Sybex
Berkeley, CA, 1981
253 pages, softcover
$12.95

Reviewed by
Paul Swanson
97 Jackson St.
Cambridge, MA 02140

While BASIC is widely acclaimed as an easy-to-learn, easy-to-use programming language, teaching yourself BASIC can be a problem. The manuals that accompany many computer systems are very dry, and while you can learn BASIC (Beginner's All-purpose Symbolic Instruction Code) from them, they serve better as reference manuals than teaching guides. Some computers do come with teaching guides, but these generally explain BASIC at a very elementary level, using simple text and cartoons.

For those who don't want to learn by trial and error with a manual designed for reference, but want a more intellectually written teaching guide than the cartoon approach, *Fifty BASIC Exercises* by Jean-Pierre Lamoitier could be the book you're looking for. This book uses the learn-by-doing approach, a truly effective teaching method, well suited to programming. In the introduction, the author cautions that the book assumes some background in a scientific or technological field. I think a mathematical background in particular would be most helpful to the reader; a few of the included programs are based on mathematical algorithms that are not exactly on the tip of everyone's tongue. There is sufficient explanation, however, so that even if you aren't familiar with the mathematics you can still learn something about BASIC from the program. Then too, you might try using a reference book such as the *C.R.C. Standard Mathematical Tables* to help you with the math.

Two chapters of introductory material include discussions of flowcharting and a few basic rules and techniques, along with some simple programs to write. The remaining chapters are divided into such topics as "Elementary Exercises in Geometry," "Financial Computations," and "Statistics." Each chapter builds on the information presented in the previous chapters, and each set of new material is accompanied by at least one exercise. The exercises, which are all short BASIC programs, cover many problems commonly confronted in programming, such as finding the number of days between two dates, calculating loan repayments, sales forecasting, and several calculations involving income tax.

The programs in the book were designed to run on the Radio Shack TRS-80 and so will run with some minor changes on any system using Microsoft BASIC. Where the differences in BASIC are important, Lamoitier discusses them.

The book was translated from French and may have lost a few things in translation. The glossary, in this English version at least, is missing, and this is a serious drawback. Definitions are the most common barrier to anyone learning a new subject, and a computer language is certainly no exception. A better index would also help; as it stands, the index fails to cover many of the subjects that are in the text, and the ones that are included are listed with single page references, which makes it very difficult to relocate topics that appear in several places throughout the book. I don't know if the French version has a better index, but I find it hard to believe that no one thought to include a glossary.

From my observations, a person learning BASIC or any other first language on computers seems to go through four phases. The first, or orientation, phase is when any fears of the computer are dispelled and the rudiments of operating it are learned. This is well covered in the first two chapters alone. This brevity is geared toward the reader who is serious about, and adept at, learning, in which case more discussion at that level would be boring. The rest of the book deals quite successfully with the second phase, during which the programmer-to-be learns to write programs with loops and more sophisticated algorithms. The third phase, which the book should leave the reader ready to pursue, is when the programmer starts using a very structured approach and tackles applications that may use the programs written in phase two as interim calculations. (The fourth phase, which I see as learning data file manipulation on a large scale, is not important here.) My purpose in mentioning these phases is to state one more point about this book: in order for the person learning BASIC to be ready for the third phase, that person should be familiar with subroutine use. Lamoitier uses subroutines quite effectively in the exercises and, further, discusses organizing, or structuring, the program in general. However, I would have liked more explanations of how the subroutines fit into the scheme of structuring; as programs get more sophisticated, subroutine use gets more important.

But in general, *Fifty BASIC Exercises* is a worthwhile book. It has its shortcomings, for while the need for more discussion on subroutines can be argued, I think that most readers of the book will agree that it would benefit considerably from a glossary and an expanded index. Nevertheless, it should serve the novice well as a practical and intelligently written guide to the fundamentals of BASIC programming. ■

BYTE's Bugs

Mystery Coil Turns Up In Circuit Cellar

Several readers contacted us with a complaint about Steve Ciarcia's article "Build a Computerized Weather Station" (see the February 1982 BYTE, page 38). An inductive coil labeled only "*L1" appeared in the schematic diagram of figure 11b on page 64 with no explanation of its origin or value.

Coil L1 is meant to be wound by hand from eight turns of number-26 copper wire around a coil form with an inside diameter of one-quarter inch.

We apologize for the omission of this information, which should have been placed in the figure caption.

Thanks to Rick Parrot of Data General in Apex, North Carolina, and to others for pointing out this error. ■



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Programmer's Guide to the 1802

Tom Swan
Hayden Book Company
Rochelle Park, NJ, 1981
156 pages, softcover
$7.95

Reviewed by
Harley Shanko
15025 Vanowen, #209
Van Nuys, CA 91405

Users of the 1802 8-bit microprocessor are sure to enjoy Tom Swan's *Programmer's Guide to the 1802*. It is written in such a way that the novice should be able to understand quickly the 1802 instruction set and begin writing assembly-language programs; yet the more advanced programmer should find this book useful also. The author's style and occasional interjections of humor make for easy reading, with references and comparisons that simply and clearly illustrate the subject matter.

The book is divided into four sections. Beginning with "A System of Numbers—A Number of Systems," Swan quickly acquaints the reader with the hexadecimal number system. This foundation should allow the computer novice to proceed without difficulty through the next section, "Fundamentals of Assembly Language," to which one third of the book is devoted.

Arithmetic and logic operations are explained, using binary and hexadecimal examples to introduce various computer instructions (add, subtract, carry/borrow, complement, AND, OR, exclusive OR, and shift). Then program flow (branch, skip, and call) and data flow (load and store) are covered, as well as register control, input/output, and other features and instructions unique to the 1802. The last ten pages of this section use assembly-language routines as examples to introduce certain programming concepts.

A quarter of the book is spent clearly explaining the 1802 instruction set. Each instruction mnemonic is defined, its symbolic actions are represented, and a textual discussion and programming example are included. Sprinkled throughout the book are illustrations, tables, and figures, all courtesy of RCA; interestingly, these are not referred to by the author.

The last quarter of the book includes a thoroughly commented assembler and disassembler source listing and text describing it, a library of subroutines which can be used in many programs, and the answers to the examples included at various points by the author. The assembler does not support the use of labels, macros, or mathematical expressions; thus the user must assign starting addresses and branch and call addresses. Nevertheless, this line-at-a-time assembler allows a programmer to enter mnemonics, addresses, and immediate data, and frees him from error-prone mnemonic-to-object-code conversion. The assembler can be run on small systems (2½K bytes of programmable memory, minimum) and still provide space for assembling 1K bytes of object code.

To test its usability, I installed the assembler in my homebrew 1802 system. Despite its limitations, the assembler does provide a means to enter a program in source form and get immediate display of valid entries (invalid entries are flagged with an ERROR message) via the disassembler, which overwrites the entry display. The assembled object code can then be run, saved, or programmed into an EPROM (erasable programmable read-only memory) if both hardware and software support these last two features. It is assumed that the user can write his own "handler" which normalizes the user system and the assembler interfaces and provides a keyboard/display for the assembler/disassembler. Depending on the operating system's register usage, this handler software can range from quite simple code to the rewriting of all the keyboard input, display output, and SCRT (Standard Call and Return Technique) routines. My handler used about 150 bytes, using existing keyboard and video-display subroutines.

In summary, this book is what 1802 users have needed for years. In fact, it might have been better received five years ago when I started into microcomputing. Still, it does provide the explanations necessary to clarify several points and better explain some of the interrupt-type instructions. For all except perhaps the most advanced 1802 programmers, this book should prove to be a worthwhile acquisition. ■

Book Review

TRS-80 Color Computer Technical Reference Manual
Tandy Corporation
Fort Worth, TX
1981, 71 pages
softcover, $14.95

Reviewed by
Yvon Kolya
POB 22
Peterborough, NH 03458

I was astounded to see Radio Shack's *TRS-80 Color Computer Technical Reference Manual* on the shelf at the local Tandy Computer Center Store. After I had purchased it and began sifting through its information-packed pages, I realized what an incredible find this book was.

Radio Shack, along with many other major computer manufacturers, has had a reputation of closely guarding all the information about its computer systems, releasing only the bare minimum of facts necessary to sell the computers and software. With the appearance of this manual, Radio Shack seems to be reversing this policy.

This book gives all the information that any TRS-80 Color Computer (Level I and II) owner might want to know. It covers memory maps, block diagrams, schematics, pin connections—everything that could be of interest to either a software designer or a hardware hacker.

The Inscrutable PIA

Unfortunately, this manual is not as explicit at it should be. Apparently, it was originally written for Radio Shack's internal use, and after it was finished, Tandy decided to release it to the general public. The descriptions and explanations are quite sketchy, and I found myself rereading the material in order to make sense of it. For example, the second paragraph on page 4 states:

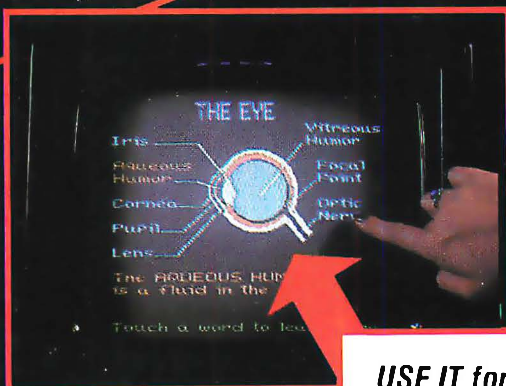
The next two pages of the Map [Color Computer Memory Map] explain the addressing for the PIA's. In general, the even numbered locations are the I/O registers and the odd numbered memory locations are the control registers. Bit two of the control registers determines what is addressed at the even numbered memory locations. If this bit is set high (logic 1) the data I/O register is addressed. If it is low the data direction register is addressed. Normally the data direction register is addressed only during initialization to allow configuration of the data inputs and outputs. (By clearing bit 2 and writing to the even numbered memory location one address below, each bit of the PIA may be set as an input or an output. A 1 in the data direction register sets the bit as an output and a 0 sets the bit as an input.)

When I proceeded to the corresponding diagram, I found it was not clear to which of many registers the paragraph

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was referring. In general, the explanations are too terse.

Section 1, which is 11 pages long, is devoted to a block diagram of the Color Computer and to a series of precise memory maps of the random-access memory.

These maps are very useful if you like to experiment with the different memory pages, modes, and displays. For example, I found out how to get limited higher-density video graphics on my Level I 4K-byte system after only a little experimentation. And using the POKE command to place a 0 into location FFD7 causes the system to operate at a clock rate of 1.8 MHz instead of the normal .89 MHz.

Section 2 is only two pages long and details the proper sequence of operations needed to disassemble the computer, as well as the reassembly procedure.

Section 3, "Theory of Operation," concentrates on the 6809E microprocessor, which is the heart of the TRS-80 Color Computer, and how it is interfaced to the outside world through the rest of the computer's components. Block diagrams, programming models, timing diagrams, cassette formats, and peripheral schematics are all included in the 26 pages that comprise this section. All of the components of the system are covered: joysticks, the RS-232C serial port, sound port, cassette port, and power supply.

The next section, labeled "Troubleshooting," lays down general guidelines on where to look for the most common problems that you may encounter. Like the rest of the manual, the explanations do leave a lot unsaid and aren't very thorough. For example, the sound went out on my computer, and I discovered, much to my dismay, that the audio circuitry isn't covered in the troubleshooting section. However, using the schematics in the following sections, I was able to diagnose the problem and locate the bad chip on the circuit board.

Sections 5, 6, and 7 are gold mines for the hardware hacker. Section 5 features a complete list of all of the parts used in the Color Computer, including the screws! Section 6 is an actual-scale drawing of both the component side and the printed-circuit side of the computer board used in the Color Computer. Section 7, the last one in the manual, is composed of three 11 by 16 inch fold-out pages that give the complete circuit diagram of the Color Computer.

The *TRS-80 Color Computer Technical Reference Manual* (order no. 26-3193) is a bit skimpy on the explanations, but the diagrams and schematics more than make up for these deficiencies. If you are interested in the hardware/interfacing aspect or the software aspect, or even if you're just curious about the machine, then I recommend this manual. ■

BYTE's Bits

Computer Stores Listed

A mailing list of all the known computer stores in the United States and Canada has been compiled by NACS (National Association of Computer Stores). Approximately 1500 stores are listed, and most entries contain company name, street address, city, state, and zip code. The list is broken down by state and includes a number of entries for foreign countries.

The list is available for $110. For details, contact the National Association of Computer Stores, 3255 South U.S.#1, Fort Pierce, FL 33450, (305) 465-9450. ■

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Structured Strings in BASIC

Dr. David W. Stockburger
Psychology Department
Southwest Missouri State University
Springfield, MO 65802

The applications programmer often needs to create a sequence of events to direct the activity of a program. In many cases, the events are repeated at various levels within the sequence. The following describes a general-purpose routine in BASIC that allows the programmer to create a great variety of structured strings easily; these strings may then be used to sequence events in control programs. It has potential use in music generation, industrial control, robotics, and animation.

As an example, suppose a program to demonstrate animation techniques had 26 possible screens or displays, each symbolized by a small letter *a* through z. Input to this program might be in the form of a string (e.g., <*aabzzcabzrabz*>), which would sequentially display the screen associated with each small letter. These strings can be constructed and entered by the user. This may be a laborious task, however, if the input strings are long and complicated. Because it is likely that some patterns of small letters are repeated within the final string, considerable time and effort can be saved by creating a production system that inputs strings of capital and/or small letters (e.g., <*aBZcD*>) and produces strings consisting of only small letters (e.g., <*aaabccdefcddd*>). A set of production rules govern the replacement of any capital letter by a string of capital and/or small letters.

In this routine, an initial string of capital and/or small letters entered by the user is expanded until a string with only small letters remains; this last string is called the structured string. The expansion is performed by user-defined production rules. A production rule is a string that begins with a capital letter and is followed by capital and/or small letters.

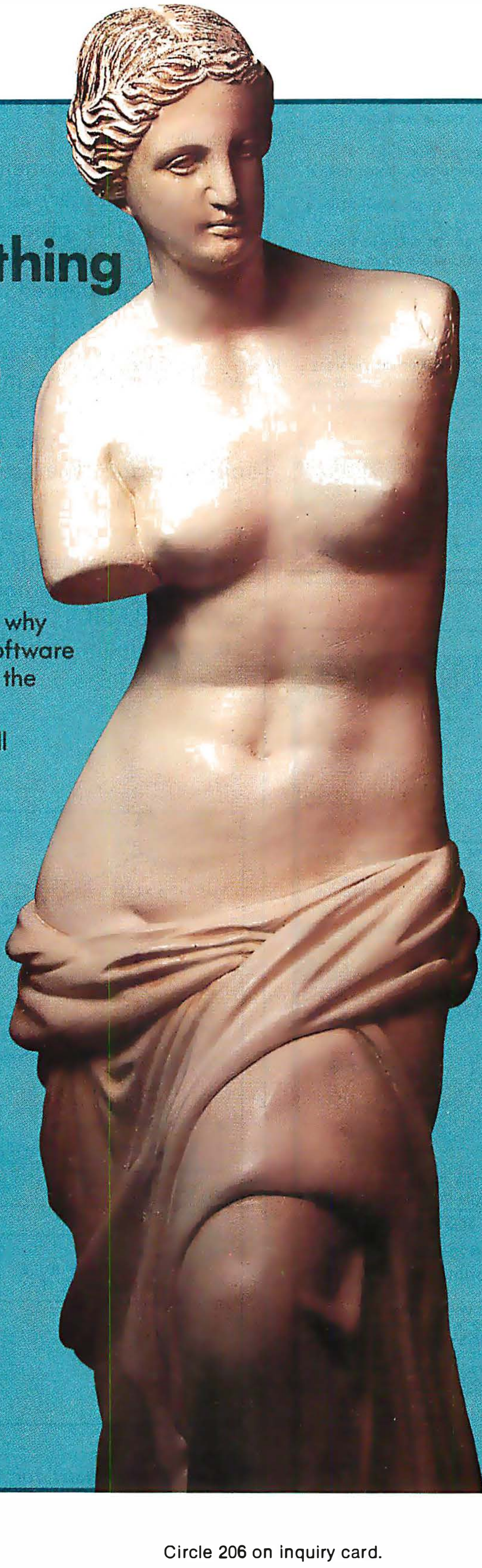
The routine works by setting the pointer to the first letter in the initial string and examining that symbol. If it is a small letter, the routine increments the pointer and repeats the process. If it is a capital letter, it expands the initial string by replacing the capital letter with all symbols that follow it in the appropriate production rule. The pointer is *not* incremented in this case and the process is repeated, beginning at the position of the first letter of the newly inserted string. If a symbol is encountered that is neither a capital letter for which a production rule has been defined nor a small letter, the routine will generate an error. The routine will repeat the above process until the expanded string contains only small letters or until a string longer than some predefined length results. The flowchart for this routine is presented in figure 1.

For example, given the following set of production rules:

AaabbB
Bcccd
CeAe
DABCD

and the initial string <*CD*>, the routine proceeds as follows: it initially sets the pointer (*p*) to 1 and expands <*C*> in <*CD*>. The result is the string <*eAeD*>. When the routine now finds a small letter <*e*> in the

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first position of the string, it increments the pointer and examines the second letter in $<eAeD>$, which is $<A>$. Finding a capital letter, it looks it up in the set of production rules, finds it, and expands the string to $<eaabbBeD>$. The next capital letter to be expanded is $<B>$, and the expanded string would now be $<eaabbcccdeD>$. Continuing the process would yield $<eaabbcccdeABCD>$, which could be infinitely expanded. The routine would stop, however, because the pointer would have become larger than the limit set by the user.

The BASIC routine (written in Poly Disk BASIC for a Poly-88 computer) as described above is presented in listing 1. The production rules are read in as data statements in the string variable T$. If different production rules are desired, they may be substituted or added to the existing data statements. If a number of different production systems are desired, it would probably be easiest to store them in mass storage, such as disk or tape files, and read them into T$ as desired.

The string variable A$ is used for both the input and output string. The user inputs the initial string into the routine through this variable, and the routine returns the expanded string back into this variable. The routine uses the BASIC commands RIGHT$, LEFT$, and MID$ to accomplish the expansion. (This should pose no problem for most BASICs.) Examples of the results of the routine are presented in listing 2.

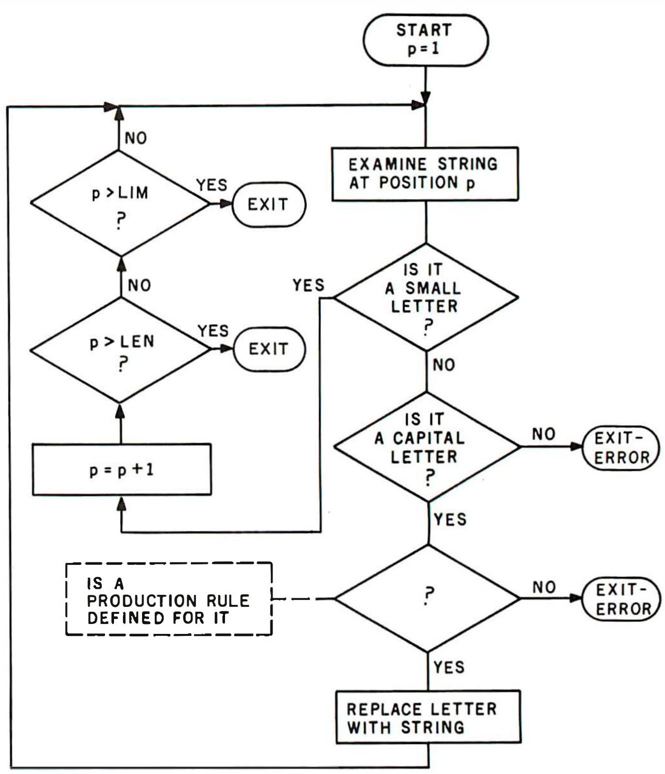


Figure 1: *Flowchart for the structured string-generation program in listing 1.*

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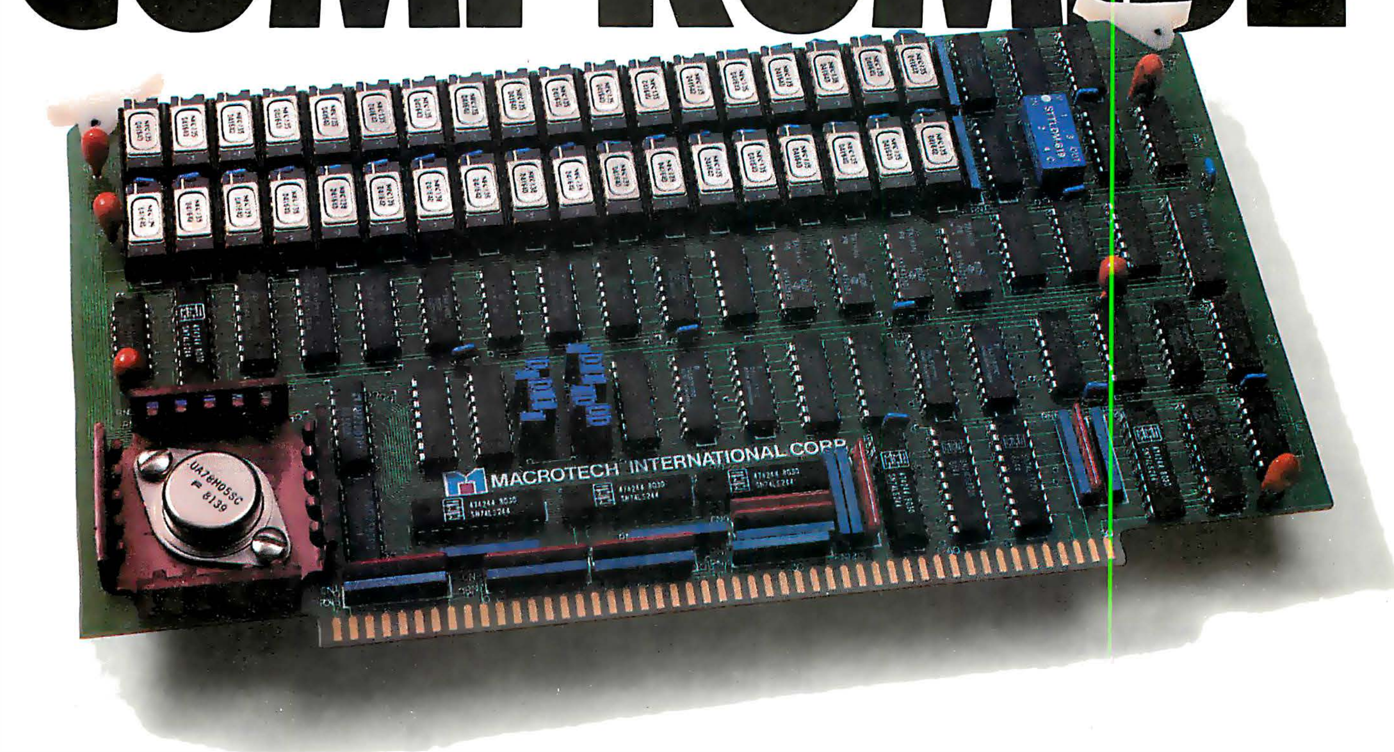
Listing 1: *The structured string-generation program (written in Poly Disk BASIC). In practical applications, this program would be used as part of a larger program.*

```
10 REM *******  STRINGS  *******
20 REM A PROGRAM TO GENERATE STRUCTURED STRINGS
30 REM
40 REM Copyright, 1981 by David W. Stockburger
50 REM                      PSYCHOLOGY DEPARTMENT
60 REM                      SOUTHWEST MISSOURI STATE UNIVERSITY
70 REM                      SPRINGFIELD, MISSOURI 65804
80 REM
90 DIM S$(1:400)
100 REM CONTAINS STRING TO BE GENERATED
110 DIM T$(26:20)
120 REM CONTAINS PRODUCTION RULES
130 DIM A$(1:1)
140 REM TEMPORARY STRING USED BY STRINGS
150 REM
160 REM READ IN TRANSFORMATION STRINGS TO BE USED
170 REM N IS THE NUMBER OF TRANSFORMATION STRINGS
180 N=10
190 FOR I=1 TO N
200 READ T$(I)
210 NEXT
220 DATA "Aasbbcc"
230 DATA "Bcdefgh"
240 DATA "CtABt"
250 DATA "Dxyz"
260 DATA "Etiser"
270 DATA "Fnnop"
280 DATA "GvFZeeD"
290 DATA "HGCEH"
300 DATA "IwwzcbDBACH"
310 DATA "Zmmm"
320 REM
330 INPUT "Enter maximum length of expanded string (1 to 300)  ",L
340 INPUT "ENTER STRING TO BE EXPANDED  ",S$
350 GOSUB 430
360 PRINT S$
370 INPUT "Do you wish to continue (Y or N)?  ",A$
375 PRINT
380 IF A$="N" THEN STOP
390 IF A$="Y" THEN 340
400 GOTO 370
410 REM
420 REM
430 REM *******  SUBROUTINE TO EXPAND STRINGS  *******
440 REM
450 P=0
460 REM P IS POSITION IN STRING
470 REM FIND CURRENT LETTER
480 P=P+1
490 IF P>L THEN RETURN
500 IF P>LEN(S$) THEN RETURN
510 A$=MID$(S$,P,P)
```

Listing 1 continued on page 314

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Listing 1 continued:

```
520 IF A$>="a" AND A$<="z" THEN 470
530 IF A$<"A" OR A$>"Z" THEN 670
540 REM THE LETTER IS A CAPITAL
550 REM CAN EXPANSION LETTER BE FOUND?
560 J=0
570 FOR I=1 TO N
580 IF A$=LEFT$(T$(I),1) THEN J=I
590 NEXT
600 IF J=0 THEN 720
610 REM IF J=0 THEN NO EXPANSION LETTER WAS FOUND
620 REM NOW EXPAND USING J
630 L1=LEN(T$(J))-1
640 L2=LEN(S$)-P
650 S$=LEFT$(S$,P-1)+RIGHT$(T$(J),L1)+RIGHT$(S$,L2)
660 GOTO 510
670 REM ERROR - SYMBOL IN STRING NOT A CAPITAL OR SMALL LETTER
680 PRINT "ERROR IN INPUT STRING OR PRODUCTION RULE"
690 PRINT "THE INCORRECT SYMBOL WAS  ",A$
700 PRINT
710 RETURN
720 REM ERROR - PRODUCTION RULE NOT FOUND IN TRANSFORMATION TABLE
730 PRINT "CAPITAL LETTER NOT A PRODUCTION RULE"
740 PRINT "THE INCORRECT SYMBOL WAS  ",A$
750 PRINT
760 RETURN
```

Listing 2: *Examples of structured string generation from program in listing 1. The production rules used are given in lines 220 through 310 of listing 1.*

```
ENTER STRING TO BE EXPANDED  sdefslKiqwZBCD
sdefslKiqwmmmcdefshtaabbccccdefshtxyz
Do you wish to continue (Y or N)?  Y

ENTER STRING TO BE EXPANDED  J9T
CAPITAL LETTER NOT A PRODUCTION RULE
THE INCORRECT SYMBOL WAS  J

J9T
Do you wish to continue (Y or N)?  Y

ENTER STRING TO BE EXPANDED  EFG
tisernnopvnnopmmmmeexyz
Do you wish to continue (Y or N)?  Y
```

Cautions

Remember:

- The string variable A$ must be dimensioned longer than the cutoff limit given to the routine because, upon exiting the routine, the expanded string may contain both small and capital letters to the right of this length. The additional length needed will depend upon the type of production rules that have been employed.
- The replacement string of a production rule may not contain the capital element in the first position. For instance, *AAa* is not permitted because first position would never be expanded to a small letter. More complex versions of the same phenomenon may occur when replacement rules cyclically replace capital letters. For example, the replacement rules *ABa* and *BAb* would recursively call one another without replacing the initial portion of the string by small letters.
- The routine is fairly slow and may not function in real-time applications, where short time intervals (i.e., seconds) are important. For example, it would probably not be possible to generate strings of musical notes and play them simultaneously with the result sounding anything like music. Where time is critical, the strings must first be generated and stored in a mass storage medium, such as floppy disk, tape, or programmable memory. They may then be recalled when needed.
- The routine cannot easily generate all useful strings. Some transformations of existing strings cannot be produced by this routine. For example, when a musical phrase an octave higher or lower than an existing phrase is desired, it may not be easily produced using this system.

The inspiration for the routine came from the discussion of formal systems by Douglas Hofstadter (in *Gödel, Escher, Bach: an Eternal Golden Braid*, Basic Books, New York, 1979) and the formal theory of grammar (see *Automata Theory: Machines and Languages* by Richard Y. Kain, McGraw-Hill, New York, 1972). In these systems, a given string is expanded by the use of production rules to generate an axiom (discussed by Hofstadter) or an element of the language (discussed by Kain). The major difference between these systems and the present one is that, in the former cases, each capital letter may have a number of different replacement strings so that any number of possible expansions are possible, defining either a formal system or formal language. In the case of the above routine (where only one possible expansion is allowed for any capital letter), the initial string will always produce the same expanded string. ■

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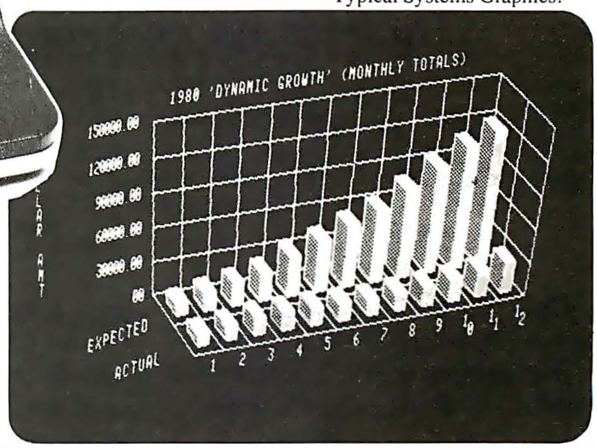
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TRS-80 BASIC Program Hang-ups

The Reasons and Some Solutions

Understand and eliminate those mysterious crashes

Glenn Tesler
POB 83
North Hollywood, CA 91603

Have your TRS-80 BASIC programs ever stopped for no apparent reason or hung up in the middle of an operation? There are at least six reasons why this can happen:

1. The program is trying to output to a nonexistent printer or to one that's not ready.
2. String space collection, also known as garbage collection, is taking place.
3. Your program is large and has many line references to the middle or end.
4. Your program uses variables that were not defined in the *proper* order (the proper order will be explained later).
5. Your program is stuck in an endless loop.
6. Your system has crashed, your memory has dropped out, etc.

These problems occur often, and can be annoying, especially when you have to load the program again and start over. Here are some solutions to the first four possibilities, some of which should improve your program execution time.

Printer Not Ready

Occasionally, you may run a program that contains LPRINT (output to printer) statements when your printer is off or disconnected. If so, your program will hang up when it reaches the first LPRINT, because the TRS-80 printer-driver software waits until the printer sends a ready signal before it transmits each character to be output. If the printer is off, this software routine never receives the ready signal, staying in a loop without sending a warning message to the user. To prevent this, you need a routine that checks for the printer's presence without getting stuck. Listing 1 shows two methods, using both BASIC and Z80 machine language, that will alert you to the printer-not-ready situation.

Often a TRS-80 BASIC program will stop during an operation for no apparent reason.

If you use the NEWDOS operating system, accidentally pressing the J, K, and L keys simultaneously (the NEWDOS screen-print command) will result in a hang-up for the same reasons. To prevent this, you can disable the screen print by POKEing the decimal number 201 (hexadecimal C9) into decimal location 17333 (hexadecimal 43B5). To re-enable this function, you must POKE the decimal number 103 (hexadecimal 67) into the same location.

Garbage Collection

If you define 20 strings as 3 characters in length and then you redefine those same 20 strings as 2 characters, it should take up 40 bytes, right? Wrong! It takes 100 bytes: 60 for the old strings—now garbage—and 40 for the new strings. Eventually, the computer has to get rid of the garbage to free string space. This procedure sometimes seems to take forever.

The program in listing 2 repeatedly picks a random number from five to nine and defines 100 strings to that length; the random numbers are displayed between the asterisks. The program also shows how much string space is left in memory. Occasionally, this program pauses when the numbers get low. This means that it is time for string space compression, also known as garbage collection, which the computer usually does without a warning. This doesn't have to happen anymore!

Save the BASIC program from listing 2, then decide whether you want to use BASIC or machine language to create a string-compression detector. If you select BASIC, enter the program in listing 3; use the program in listing 4 if you select machine language.

The BASIC version POKEs a machine-language program similar to that in listing 4 into memory. Before running the BASIC version, you must

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Listing 1: *Two methods of alerting a user to a printer-not-ready condition on a TRS-80 Model I. Listing 1a is a one-line BASIC statement that prints a warning message if the printer is absent. Listing 1b is the machine-language equivalent (users must write their own code to display the warning).*

1a

```
IF (PEEK(14312) AND 240)<>48 THEN PRINT"PRINTER IS NOT READY"
```

1b

```
LOOP    CALL    5D1H        ;IS PRINTER READY?
        JR      Z,PRTRDY    ;YES, START PRINTING
        CALL    PRTMSG      ;DISPLAY WARNING (CODE NOT SHOWN)
        CALL    49H         ;WAIT TILL KEY PRESSED
        JR      LOOP        ;SO WE CAN TEST AGAIN
PRTRDY  EQU     $           ;PRINTER IS READY
```

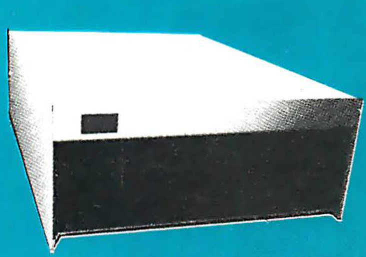
set the TRS-80 memory size to at least 71 bytes below the actual end of memory (or at least 65 bytes below where you usually set it if you have other programs in high memory). When you run it, the program will ask where in memory you want the machine-language program to be POKEd. Answering with an ENTER will tell the program to use the current memory size. An address below the memory size will result in an error; otherwise, the program will POKE the data to the location specified.

To use the machine-language version, first assemble the source code given in listing 4 using a TRS-80 assembler. If you are using a tape-based system (Level II), save the object (executable) code to tape with the name CKSTR. Then reset the memory size as described above, ready the tape for loading, go into the system mode, type in "CKSTR," and hit ENTER to begin loading. When the tape is loaded, type "/" and ENTER. This will run the CKSTR program and return to BASIC. On a disk-based system, save the object code to disk with the name CKSTR. Type in this file name when you are in DOS (disk operating system). It will load, initialize, and return to DOS. You should then enter BASIC, setting your memory size as explained above.

Once you have a version of CKSTR in memory, load and run the program in listing 2 again. When it is time for a string compression to occur, the CKSTR routine displays a graphic character that looks like the letter C (for compression) in the

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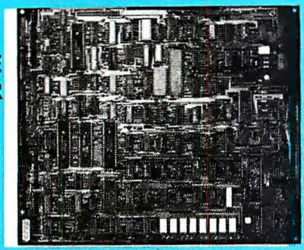
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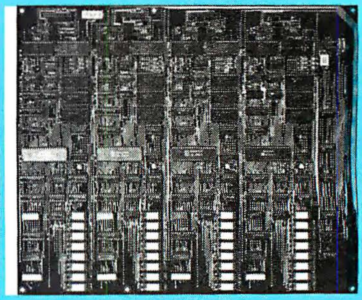
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Listing 2: *This BASIC program will show the delays caused by TRS-80 string compression and how these delays are caused by the way string space is maintained.*

```
100 'STRING       (c) COPYRIGHT 1980 by Glenn Tesler
110 '
120 'THIS PROGRAM SHOWS THE DELAYS CAUSED BY STRING
130 'COMPRESSION, AND ALSO HOW THESE DELAYS ARE CAUSED
140 'BY THE WAY STRING SPACE IS MAINTAINED.
150 '
160    GOTO 560                           'GO DO INITIALIZATION
170 '
180    A=RND(5)+4                         'PICK A RANDOM LENGTH
190                                       'FROM 5-9.
200 '
210    PRINT : PRINT "*"; A; "*"          'DISPLAY IT BETWEEN
220                                       'ASTERISKS
230 '
240 'NOW DEFINE EACH ELEMENT IN THE ARRAY TO THE RANDOM LENGTH
250 'WHICH WAS JUST PICKED. THEN, DISPLAY THE AMOUNT OF
260 'STRING SPACE LEFT TO ALLOCATE TO STRINGS BEFORE GOING
270 'THROUGH THE STRING COMPRESSION ROUTINE. FRE(A$) IS NOT
280 'USED SINCE IT INVOKES THE STRING COMPRESSION ROUTINE,
290 'AND THAT WOULD DEFEAT THE PURPOSE OF THIS EXAMPLE.
300 '
310    FOR B=1 TO X/10                    'ARRAY ELEMENT COUNTER
320      A$(B)=STRING$(A,32)              'DEFINE AN ELEMENT
330                                       'TO THE RANDOM LENGTH
340      X1=PEEK(16598) + 256*PEEK(16599) 'STRING WK AREA PTR
350      X2=PEEK(16544) + 256*PEEK(16545) 'START OF STRING DATA
360                                       'POINTER
370      PRINT X1-X2;                     'CALCULATE & DISPLAY
380                                       'THE AMOUNT OF FREE
390                                       'STRING SPACE
400      NEXT B                           'LOOP TILL EACH ELEMENT
410                                       'HAS BEEN DEFINED
420    GOTO 180                           'PICK A NEW RANDOM
430                                       'LENGTH
440 '
450 '     E N D   O F   M A I N   P R O G R A M
460 '
470 '
480 'INITIALIZATION
490 '
500 'ALLOCATE STRING SPACE. WHEN THE ARRAYS ARE DEFINED, THE
510 'AMOUNT OF STRING SPACE ALLOCATED BY THE CLEAR/10 WILL BE
520 'THE NUMBER OF ARRAY ELEMENTS IN ALL. THIS WAY, YOU CAN
530 'CAUSE MORE STRINGS OR LESS STRINGS TO BE DEFINED TO
540 'RANDOM LENTHS. CURRENTLY, THERE ARE 100 STRINGS IN ALL.
550 '
560    CLEAR 1000
570    CLS                                'CLEAR SCREEN
580    DEFINT A-W,Y-Z                     'USE INTEGERS FOR SPEED
590 '
600 'PRE-DEFINE VARIABLES FOR SPEED
610    A=0 : B=A : X1=0 : X2=0
620 '
630 'GET AVAILIBLE STRING SPACE. FRE IS BEING USED AS THERE
640 'HAVE BEEN NO STRINGS DEFINED ALREADY, THUS NO GAPS
650 'HAVE BEEN CREATED.
660 '
670    X=FRE(A$)
680 '
690 'NOW SET UP AN ARRAY.
700 '
710    DIM A$(X/10)
720    GOTO 180
```

Listing 3: *This BASIC program tells the user if any string compression or garbage collection is occurring by displaying a graphics character in the upper right-hand corner of the screen.*

```
1000 'ROUTINE TO POKE "STRING COMPRESSION DETECTOR" INTO MEMORY
1020 '         (c) COPYRIGHT 1980  by  Glenn Tesler
1040 '
1060    GOTO 4120                       'GO DO INITIALIZATION
1080 '
```

Listing 3 continued on page 324

upper right-hand corner of the screen. When the garbage collection is finished, the character is removed. With this routine in memory, you will never have to wonder if the computer has crashed or is merely collecting garbage.

The garbage collection routine (starting at hexadecimal location 28E6) uses the Z80 RST instruction, and my detection program takes advantage of this. An RST causes the processor to begin executing at a location in low memory; the garbage collector contains an RST 18, effectively the same as a subroutine call to location hexadecimal 18. Contained in this location, which is in ROM (read-only memory), is a jump vector to another location in programmable memory (hexadecimal 4006), which in turn points to the routine that is the target of programs calling this particular RST. By replacing the information in the second jump vector (locations 4006 to 4008 hexadecimal), any call to RST 18 must first go through my program, where it then checks to see if the call came from the compression routine. If so, the graphics character is displayed, a "switch" in memory is set, and the program jumps to the original target of the RST 18; otherwise, it just does the RST 18.

To erase the graphics character when the compression routine is finished, RST 20 is also checked. This points to a routine that tests data type (i.e., string, integer, etc). Since almost every command has to check the data type, RST 20 is used a lot. When this RST is called, the program checks to see if the "switch" in memory is set and the graphics character is being displayed. If so, it resets the switch and erases the character, and continues with the regular RST 20.

The machine-language program is only 65 bytes long, including the initialization routine. If you are wondering whether an RST 20 is performed in the string-compression routine, it is not. Also, if you are wondering why I didn't use FRE(A$) in the BASIC program, it is because it uses the string-compression routine before calculating the available string space.

Listing 3 continued:

```
1100 'SET UP A DEFAULT LOAD ADDRESS AT WHICH TO POKE DETECTOR,
1120 'THEN LET USER OVERRIDE IT IF NECESSARY
1140 '
1160     M1=M                         'DEFAULT LOAD ADDRESS
1180     CLS                         'BEGIN WITH FRESH SCREEN
1200     PRINT "WHERE SHOULD THE STRING COMPRESSION DETECTOR"
1220     PRINT "       BE LOADED  (DEFAULT IS:"; M1; ")";
1240     INPUT M1
1260     IF M1 >= M THEN 1460       'LOAD POINT MUST BE>=MEM SIZE
1280     PRINT
1300     PRINT "MEMORY SIZE IS SET AT"; M;        'ERROR MESSAGE
1320     PRINT "SO RESET MEMORY SIZE AND TRY AGAIN"
1340     END : GOTO 1300            'DON'T LET PROGRAM CONTINUE
1360 '
1380 'SAVE FINAL LOAD ADDRESS, THEN CONVERT IT TO VALID VALUES
1400 'FOR THE "POKES": 0-32767 REMAIN THE SAME, BUT
1420 '65536 MUST BE SUBTRACTED FROM 32768-65535.
1440 '
1460     M=M1                         '"M" IS LOAD ADDRESS FOR PGM.
1480     IF M > 32767 THEN A=M-65536 ELSE A=M
1500 '
1520 'POKE THE MACHINE LANGUAGE PROGRAM INTO HIGH MEMORY.
1540 'ANOTHER ROUTINE WILL HANDLE THE RELOCATION AS NEEDED.
1560 '
1580    PRINT : PRINT "NOW POKING PROGRAM INTO HIGH MEMORY..."
1600    FOR B=1 TO NB               'LOOP TO DO THE POKES
1620      READ C                    'ONE BYTE AT A TIME
1640      POKE A,C                  'INTO HIGH MEMORY
1660      IF A=32767 THEN A=-32768 ELSE A=A+1    'CHECK BOUNDARY
1680      NEXT B                    'TO KEEP 'A' A VALID INTEGER
1700 '
1720 'INTEGERS MUST BE IN THE RANGE:  -32768 TO 32767
1740 'IF "M" EXCEEDS 32767, IT WOULD BE AN ERROR.  BY
1760 'SUBTRACTING 65536 FROM "M", A NEGATIVE NUMBER RESULTS,
1780 'WHICH ACTUALLY IS A Z-80 ADDRESS BETWEEN 32768 AND 65535
1800 '
1820   IF M > 32767 THEN M=M-65536      'CHECK AND ADJUST RANGE
1840 '
1860 'MACHINE LANGUAGE IS NOT SELF-RELOCATABLE,
1880 'SO NOW IT IS NECESSARY TO CALCULATE AND ADJUST SOME
1900 'OF THE ADDRESSES IN IT.
1920 '
1940 'THE CALCULATION IS DONE THIS WAY:
1960 '  1. CALCULATE ABSOLUTE ADDRESS OF A VARIABLE
1980 '     WITHIN THE MACHINE LANGUAGE PROGRAM:
2000 '        M0 = PROGRAM LOAD ADDRESS + VARIABLE DISPLACEMENT
2020 '              WITHIN PROGRAM
2040 '  2. CONVERT ADDRESS 'M1' TO TWO SINGLE BYTES: LSB, MSB:
2060 '        M2 = LSB, M1 = MSB
2080 '  3. CALCULATE WHERE TO STORE ADJUSTED VARIABLE ADDRESS
2100 '     AND STORE IT THERE.  THIS MAY HAVE TO BE DONE MORE
2120 '     THAN ONCE IF THE VARIABLE IS REFERENCED MORE THAN
2140 '     ONCE.
2160 '
2180    PRINT : PRINT "NOW RELOCATING INTERNAL ADDRESSES..."
2200    M0=M+13                     'ADDRESS OF GRAPHIC DISPLAY RTN
2220    M2=M0 AND 255               'EXTRACT LSB FROM 2-BYTE ADDR.
2240    M1=INT(M0/256) AND 255      'EXTRACT MSB ALSO
2260    POKE M+1, M2                'STORE LSB INTO MACH LANG PGM
2280    POKE M+2, M1                'STORE MSB
2300 '
2320    M0=M+38                     'ADDRESS OF "GRAPHIC REMOVER"
2340    M2=M0 AND 255               'CALC LSB OF GRAPHIC REMOVER
2360    M1=INT(M0/256) AND 255      'CALC MSB
2380    POKE M+7, M2                'STORE THEM INTO PROGRAM
2400    POKE M+8, M1
2420 '
2440    M0=M+64                     'ADDRESS OF A SWITCH IN PGM
2460    M2=M0 AND 255               'LSB OF SWITCH ADDRESS
2480    M1=INT(M0/256) AND 255      'MSB
2500    POKE M+33, M2               'STORE SWITCH ADDRESS INTO
2520    POKE M+34, M1               'PROGRAM IN THREE LOCATIONS.
2540    POKE M+39, M2               'IN THREE PLACES
2560    POKE M+40, M1
2580    POKE M+47, M2
2600    POKE M+48, M1
```

Listing 3 continued on page 326

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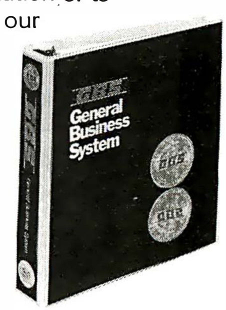
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Listing 3 continued:

```
2620 '
2640 'NECESSARY RELOCATIONS ARE COMPLETE.
2660 '
2680 'SET UP THE "USR" CALL: ASSUME LEVEL II, BUT IF IN
2700 'DISK BASIC, SET IT UP THROUGH A "DEFUSR":
2720 '
2740    POKE 16526, M AND 255             'LSB OF DETECTOR START
2760    POKE 16527, (M/256) AND 255       'MSB
2780 '
2800 'NOW SEE IF IN DISK BASIC.  IF SO, ABOVE DIDN'T HURT.
2820    IF PEEK (16809) <> 201 THEN DEFUSR=M
2840 '
2860 'NOW ACTIVATE THE STRING COMPRESSION ROUTINE.
2880 'IT WILL REMAIN IN HIGH MEMORY UNTIL YOU RE-BOOT OR
2900 'RE-INITIALIZE BASIC.  YOU CAN LOAD AND RUN OTHER
2920 'BASIC PROGRAMS NOW, AS LONG AS THEY DO NOT POKE OTHER
2940 'MACHINE LANGUAGE PROGRAMS INTO THE SAME PLACE AS THE
2960 'STRING COMPRESSION ROUTINE.
2980 '
3000 '   *** MAKE SURE YOUR OTHER PROGRAMS DO NOT ***
3020 '   ***       DESTROY THE DETECTOR !!!        ***
3040 '
3060    M=USR(0)                     'ACTIVATE THE DETECTOR
3080 '
3100 'END OF MAINLINE OF PROGRAM
3120 '
3140    PRINT : PRINT "STRING COMPRESSION DETECTOR ACTIVE"
3160    END : GOTO 3160               'MAKE SURE PROGRAM STOPS HERE
3180 '
3200 '         E N D   O F   M A I N   P R O G R A M
3220 '
3240 '
3260 'ERROR ROUTINE FOR HANDLING OVERFLOWS IN A CERTAIN BLOCK
3280 'OF LINES.  IF THE ERROR IS SOMEPLACE ELSE, OR IS NOT
3300 'AN OVERFLOW, THEN BASIC'S NORMAL ERROR MESSAGE IS GIVEN.
3320 'IF IT IS AN OVERFLOW IN THAT BLOCK, THEN THIS ROUTINE
3340 'MODIFIES THE APPROPRIATE VARIABLE.
3360 '
3380 'CHECK TO SEE IF VALID ERROR
3400 '
3420   IF ERR<>10 OR ERL<2200 OR ERL>2820 THEN ON ERROR GOTO 0
3440 '
3460 'IF ERROR OCCURED WITH M0, CHANGE M0 ELSE CHANGE M
3480 '
3500   IF ERL=2200 OR ERL=2220 OR ERL=2240 THEN 3700
3520   IF ERL=2320 OR ERL=2340 OR ERL=2360 THEN 3700
3540   IF ERL=2440 OR ERL=2460 OR ERL=2480 THEN 3700
3560 '
3580 'IN THE NEXT TWO LINES:  IF THE VARIABLE IS NEGATIVE,
3600 '65536 IS ADDED. IF POSITIVE, 65536 IS SUBTRACTED. THIS
3620 'SHOULD TAKE CARE OF THE OVERFLOW. NEXT IT RESUMES TO
3640 'GIVE CONTROL BACK TO THE ERROR LINE.
3660 '
3680   M=M+(-SGN(M)*65536) : RESUME
3700   M0=M0+(-SGN(M0)*65536) : RESUME
3720 '
3740 '         E N D   O F   E R R O R   R O U T I N E
3760 '
3780 '
3800 'THESE DATA STATEMENTS CONTAIN THE MACHINE LANGUAGE
3820 'PROGRAM THAT IS THE "STRING COMPRESSION DETECTOR"
3840 '
3860 DATA  33, 181, 255,  34,   7,  64,  33, 206, 255,  34
3880 DATA  10,  64, 201, 227, 213,  17, 253,  40, 205, 144
3900 DATA  28, 209, 227,  32,  10,  62, 183,  50,  63,  60
3920 DATA  62,   1,  50, 232, 255, 195, 144,  28,  58, 232
3940 DATA 255, 203,  71,  40,  16, 175,  50, 232, 255,  58
3960 DATA  63,  60, 254, 183,  32,   5,  62,  32,  50,  63
3980 DATA  60, 195, 217,  37,   0
4000 '
4020 '         E N D   O F   D A T A   S T A T E M E N T S
4060 '
4080 'INITIALIZATION
4100 '
```

Listing 3 continued on page 328

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Computer Benchmarks—All systems running the same BASIC program.

Manufacture-Model	Class	Operating System	Language (Type*)	Run Time (Seconds)
IBM 3033	Mainframe	VS2-10RVYL	Stanford BASIC	10
Seattle Computer System 2	Micro	MS-DOS	Microsoft BASIC (C)	33
Digital Equipment PDP 11/70	Mini	n/a	BASIC (I)	45
Prime 550	Mainframe	PRIMOS	BASIC V16.4 (I)	63
Digital Equipment PDP-10	Mainframe	TOPS-10	BASIC (I)	65
IBM System 34	Mainframe	Release 05	BASIC (I)	129
TEI System 48	Micro	MAGIC 1.0	Microsoft BASIC (C)	178
Hewlett-Packard HP3000	Mini	Time Share	BASIC (I)	250
Seattle Computer System 2	Micro	MS-DOS	Microsoft BASIC (I)	310
Alpha Micro AM-100/T	Micro	AMOS 4.3a	Alpha BASIC (SC)	317
Digital Equipment PDP 11/45	Mini	n/a	BASIC (I)	330
Data General NOVA 3	Mini	Time Share	BASIC 5.32	517
Ohio Scientific C4-P	Micro	OS65D 3.2	Level 1 BASIC (I)	680
North Star Floating Point	Micro	NSDOS	NorthStar BASIC (I)	685
Radio Shack TRS-80 II	Micro	TRSDOS 1.2	BASIC (I)	792
Apple II+	Micro	DOS 3.2	Applesoft II (I)	960
Cromemco System 3	Micro	CDOS	32K BASIC (I)	1074
Commodore Pet 2001	Micro	n/a	Microsoft BASIC (I)	1374
IBM 5100	Micro	n/a	BASIC (I)	1951
Vector MZ	Micro	n/a	Micropolis BASIC (I)	2251

*C = Compiler; I = Interpreter. Times (except for Seattle Computer) taken from August 1981 issue of Interface Age.

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Listing 3 continued:

```
4120    DEFINT A-L,N-Z              'USE INTEGER VARIABLES
4140    M=PEEK(16561)+256*PEEK(16562)+1      'MEM SIZE
4160    ON ERROR GOTO 3420          'OVERFLOW ERROR HANDLER
4180    C=0:B=C:A=C:M1=C:M2=C       'SET UP VARIABLES FOR SPEED
4200    ON ERROR GOTO 3420          'TAKE CARE OF OVERFLOW
4220    C=0:B=C:A=C:M0=C            'SET UP VARIABLES FOR SPEED
4240    M1=C:M2=C
4260    NB=65                       'LENGTH OF MACH. LANG. PGM.
4280    GOTO 1160                   'GO BACK TO MAIN PROGRAM
4300 '
4320 '          E N D   O F   I N I T I A L I Z A T I O N
```

Line Searches

When the TRS-80 BASIC interpreter encounters a GOSUB, GOTO, RUN, LIST, etc., it has to search for the associated line number. The interpreter always starts at the beginning of the program unless it is looking for a GOTO, RUN, or GOSUB, in which case it does one of the following:

- If the line referenced is earlier than the line the command is on, it will begin the search at the start of the program.
- If the line referenced is not earlier than the line the command is on, the search begins on the command line.
- If the command is entered as a direct statement, the search begins at the start of the program.

The further the line is from the command referencing it, the longer the interpreter takes to find it. This can take a long time in large programs. Here are three ways to prevent this situation:

1. Try to use subroutines as much as possible. This cuts down wasted program space.
2. Put frequently used routines near the start of the program to reduce search time.
3. Place your initialization routines at the end of the program, and start your program with a GOSUB to the routine. Then your program won't have to waste time going over lines that are used only once.

Also, when entering additional lines near the top of a large program, it takes a long time to get the prompt after hitting ENTER. Here are several reasons for this:

- The BASIC interpreter searches for the line, starting at the beginning of the program.
- If the line is currently in the program, it is deleted. When the interpreter deletes a line, the lines above must fill the empty space.
- Next, the interpreter moves the lines that are past where the new one has to go to accommodate it.
- The line pointers for each line are changed, starting with the new line.
- The interpreter finishes up by executing a CLEAR.

Defining Variables

Here are some recommendations on how to define variables. If you define them in these ways, the time it takes to find each variable should be reduced and the program execution time should improve.

- Use integer variables whenever possible.
- Define all variables in the statements of the program that will be executed first. These statements should be placed at the end of the program, and invoked by a GOSUB from the beginning of the program, as mentioned before. Then, it will not be necessary for BASIC to scan them when looking for GOTO and GOSUB targets during the rest of the run.
- Define simple variables before defining arrays.
- Define the most frequently used variables before defining infrequently used ones. (This is mentioned in the Level II manual on page 11/2.)

Combining these suggestions, you should define your frequently used variables before your seldomly used ones. Frequently used arrays should

Listing 4: *The machine-language equivalent to listing 3.*

```
                 00100 ;CKSTR          (C) COPYRIGHT 1980 BY GLENN TESLER
                 00110 ;
                 00120 ;THIS PROGRAM TESTS TO SEE IF BASIC IS IN ITS
                 00130 ;STRING COMPRESSION ROUTINE. IF IT IS, IT DISPLAYS
                 00140 ;A GRAPHICS CHARACTER, ELSE IT CHECKS TO SEE IF THE
                 00150 ;GRAPHICS CHAR IS ON THE SCREEN. IF SO DISPLAY A BLANK.
                 00160 ;NEXT, DO RST18H
                 00170 ;
1C90             00180 RST18H   EQU     1C90H           ;16 BIT COMPARE
25D9             00190 RST20H   EQU     25D9H           ;TEST DATA TYPE
00B7             00200 CMPSYM   EQU     183             ;CHAR TO DISPLAY
                 00210 ;
F618             00220          ORG     63000           ;<== YOU MAY CHANGE THIS
                 00230 ;
F618 2127F6      00240 SETSTR:  LD      HL,CKSTR        ;OVERLAY JUMP VECTOR
F61B 220740      00250          LD      (4007H),HL      ;TO GIVE ME CONTROL.
                 00260 ;                                ;OVERLAY JUMP VECTOR
F61E 2140F6      00270          LD      HL,CKBYT        ;TO BE ABLE TO TAKE IT
F621 220A40      00280          LD      (400AH) HL      ;OFF SCREEN AFTERWARDS.
                 00290 ;
                 00300 ;SELECT ONE OF THE NEXT TWO JUMPS, DEPENDING ON WHERE
                 00310 ;YOU ARE RUNNING THIS PROGRAM AT EXECUTION TIME
                 00320 ;        (BASIC VIA "SYSTEM" OR DOS VIA "CKSTR/CMD").
                 00330 ;
F624 C3191A      00340          JP      1A19H           ;USE THIS TO ENTER BASIC
                 00350 ;        JP      402DH           ;OR USE THIS TO ENTER DOS
                 00360 ;
F627 E3          00370 CKSTR:   EX      (SP),HL         ;SAVE HL, GET RET ADDR.
F628 D5          00380          PUSH    DE              ;SAVE DE
F629 11FD28      00390          LD      DE,28FDH        ;RET ADR IF IN STR CMPRSN
F62C CD901C      00400          CALL    RST18H          ;IS IT THAT ADDRESS?
F62F D1          00410          POP     DE              ;RESTORE DE
F630 E3          00420          EX      (SP),HL         ;SAVE RET ADD, GET HL
F631 200A        00430          JR      NZ,DORS18       ;NOT ADDR, SKIP
F633 3EB7        00440          LD      A,CMPSYM        ;GET SYMBOL
F635 323F3C      00450          LD      (3C3FH),A       ;DISPLAY
F638 3E01        00460          LD      A,1             ;SET SWITCH
F63A 325AF6      00470          LD      (CMPSW),A       ;..
F63D C3901C      00480 DORS18   JP      RST18H          ;DO 16 BIT COMPARE
                 00490 ;
F640 3A5AF6      00500 CKBYT    LD      A,(CMPSW)       ;GET SWITCH
F643 CB47        00510          BIT     0,A             ;ON?
F645 2810        00520          JR      Z,DORS20        ;NO, DO RST20
F647 AF          00530          XOR     A               ;ZAP A
F648 325AF6      00540          LD      (CMPSW),A       ;ZAP SWITCH
F64B 3A3F3C      00550          LD      A,(3C3FH)       ;GET SCN BYT
F64E FEB7        00560          CP      CMPSYM          ;IS IT THE CHAR?
F650 2005        00570          JR      NZ,DORS20       ;NO, DO RST20H
F652 3E20        00580          LD      A,32            ;BLANK
F654 323F3C      00590          LD      (3C3FH),A       ;PUT BYTE ON SCREEN
F657 C3D925      00600 DORS20   JP      RST20H          ;DATA TYPE
                 00610 ;
F65A 00          00620 CMPSW    DEFB    0               ;SWITCH
0043             00630 ZSIZE    EQU     $-SETSTR
F618             00640          END     SETSTR
00000 TOTAL ERRORS

CKBYT  F640 00500    00270
CKSTR  F627 00370    00240
CMPSW  F65A 00620    00470 00500 00540
CMPSYM 00B7 00200    00440 00560
DORS18 F63D 00480    00430
DORS20 F657 00600    00520 00570
RST18H 1C90 00180    00400 00480
RST20H 25D9 00190    00600
SETSTR F618 00240    00630 00640
ZSIZE  0043 00630
```

be defined and then seldomly used arrays. All these definitions should be in an initialization routine at the end of the program, and a GOSUB at the beginning of the program should pass control to this initialization routine.

Conclusion

Even if you don't add these detection routines to your system, knowing what the computer is doing will help you avoid rebooting unnecessarily (say, during string compression). If you do add them, and use some of the variable-definition sequences suggested, then you'll find the computer doing more of what it was meant to do: making your life easier and more fun!■

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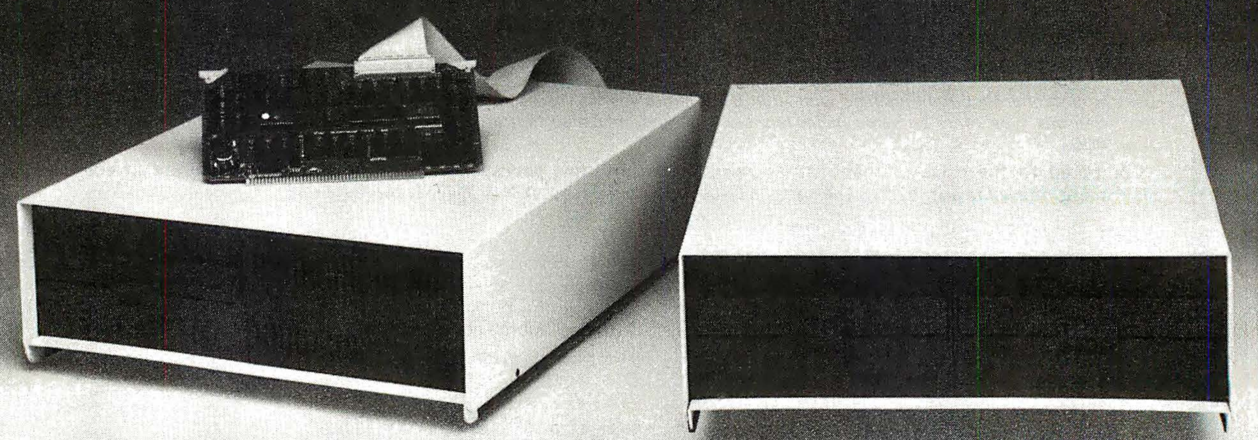
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Lear Siegler	ADM-3A	$ 635.00
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Lear Siegler	ADM-31	$1095.00
Lear Siegler	ADM-32	$1225.00
Lear Siegler	ADM-42	$1195.00
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Televideo	TVI912C	$ 725.00
Televideo	TVI 925	$ 825.00
Televideo	TVI 950C	$ 925.00

Components

4116's (200 nS)/5290-3

Apple, TRS-80, Heath

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17-49 .... $2.70 each 100 up ... $2.45 each

2708/450 nS

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340T5 .... $.70

320T12 .... $.80

340T12 .... $.75

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DB25S	$2.95	$2.75	$2.50
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Manufacturer	Model #	Price
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Manufacturer	Model #	Price
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Amdek	100-80	$ 169.00
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Anatomy and Development of a Batch-Processing System

A software system lets your computer run a series of programs without your intervention.

Gene Walters
779 Vereda Court
San Jose, CA 95123

Most microcomputer programs require responses or input from the user during their execution. For some applications, however, interactive computing has drawbacks. Programs that include updating, sorting, and listing files can take the computer a lot of time and leave you sitting idle. And many programs—even common ones for the home—do require such tasks. Suppose you want to keep a household inventory sorted by item descriptor and also by room or location or you want to catalog your collection of phonograph records and sort by title, performing artist, and composer. Programs for either of these domestic tasks would require time-consuming sorts.

Two basic approaches can be used to design programs that include lengthy operations like those described above. You can write several programs—one for updating, one for sorting, one for listing, and one for each additional function required—or you can write one large program that combines all the functions.

Each approach has advantages and disadvantages. Using the first method, you have more RAM (random-access read/write memory) free for sorting. However, you must run each program separately, which leaves you an unpleasant choice. You can watch the computer while one program executes so that you will be ready when the time comes to initiate the next program, or you can leave the computer and come back later. If you wait and watch, you waste your own time. If you leave and come back, you will find either that the program has not finished running or that the program has finished and the computer has been idle for some indefinite period. I find it frustrating to run back and forth to check on the computer's progress.

The second approach lets you enter all the desired options at the beginning of the program's run and then let the computer do all the required processing. Because all the program functions reside in memory at the same time, however, the computer may have little memory space free for processing. As a result, the program will run more slowly.

I wanted the best features of both methods: a third approach that would provide for continuous unattended running of all the required functions but leave plenty of memory space free for processing. I decided to write an executive program that would let me set up a file containing all the instructions and commands that the computer would need to run a number of separate programs in succession without operator intervention. This approach is called *batch processing*.

I developed my batch-processing system on a North Star Horizon computer with 56K bytes of RAM, a video-display terminal, and a printer. I tested the programs on both release 4 and release 5.2 of North Star system software. You can use batch-processing software like mine on any microcomputer that has a CHAIN feature (which permits one program to call another).

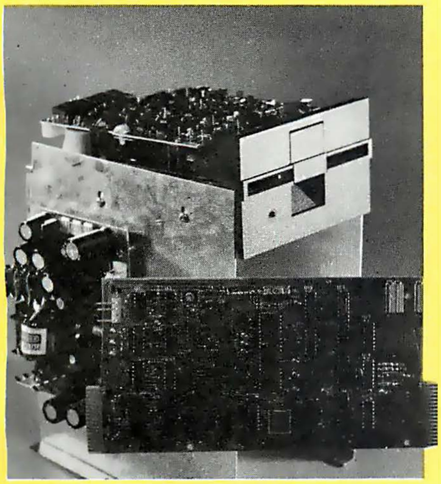
Design Goals

I tried to set up the executive program and its supporting programs in a way that would permit me to use them in many other applications without making extensive changes. I wanted to have one executive for a system consisting of many programs that would support an unattended run of several programs. I required that maximum memory, date and time information, and common parameters be available for all programs and that the parameters specific to the execution of one program be easily available.

Other features that I felt the batch-processing system should include are error checking of all input parameters

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digital

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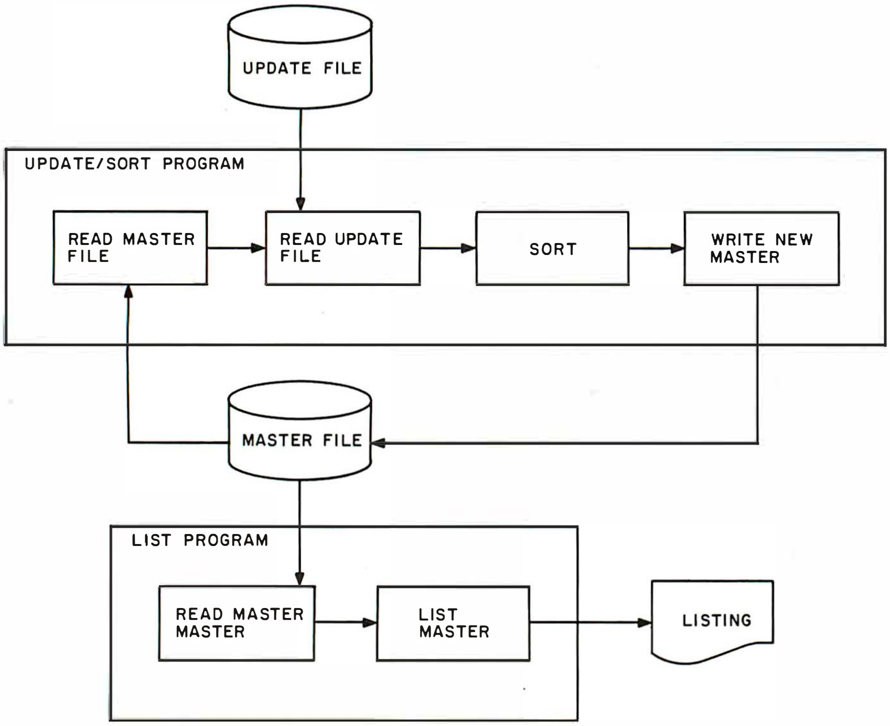


Figure 1: *A diagram of relations between the update/sort program and the list program in the Article/Book Maintenance System. Either the master file or an update file must be present before execution of the update/sort program.*

when the executive is set up to run a batch job, video display of processing status during execution, a built-in HELP command, automatic seeking of the batch-processing system on any disk drive, and cancellation of any command during job setup. The system should allow for both short and long forms of commands to the executive and for the easy addition of new commands, new programs, and additional parameters for all programs or a single program. Finally, I wanted to use general utility routines in the executive to set up job-control information.

Constructing the System

To illustrate how to construct a batch-processing system, I'll describe a set of four programs, called the Article/Book Maintenance System, for maintaining and listing a file on books and articles and show how this small system can serve as the basis for other systems.

The Article/Book Maintenance System maintains one record (a collection of a fixed number of related data items) for each article or book. Each record contains three fields (data items), one each for the title, the author, and the publication date. The system has two programs that work directly on the data:

1. a program that creates or updates the article/book master file and sorts the information by any of the three fields
2. a program that lists the current master file

Figure 1 shows the relationships among the functions performed by the update/sort program and the list program. Note that either the master file or an update file must exist before the update/sort program is run.

Execution of a single job may require calling either the update/sort program, the list program, or both more than once. A simple example is the following sequence:

1. Update an existing master file with an update file and sort the information by title.

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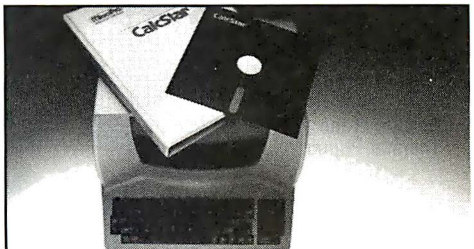
CalcStar software eliminates the need to use ledger paper ever again. It turns your video screen into a "window" on a giant electronic ledger sheet, with up to 600 entries arranged the way you want. Then, by inserting formulas into CalcStar, you create financial models that simulate the future numerically. And predict the outcomes of your business decisions.

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2. List the sorted master file.
3. Sort again, but by author.
4. List the newly sorted master file.

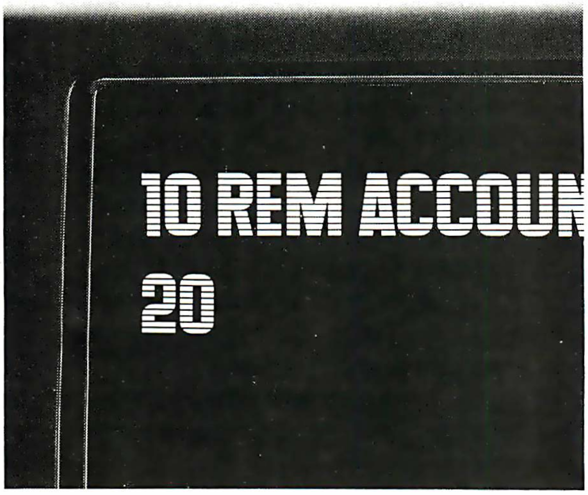
The Article/Book Maintenance System has an executive program and a subexecutive which together enable the system to call the update/sort and list programs in sequences like the one above. I'll discuss the executive and subexecutive programs in detail after I describe how the system looks in operation.

The system accepts an update file in the format of a North Star BASIC program file. Adoption of this format permits use of the North Star editor, normally used for entering BASIC programs, with the Article/Book Maintenance System. Listing 1 shows the formats for update data—title, author, and date on each new book or article. The format requires line numbers and quotes. In the absence of the quotes, the North Star editor would convert any BASIC keywords in the line to an internal representation different from an ASCII (American Standard Code for Information Interchange) string. Note the use of the minus sign after the line number of a record to be deleted.

Listings 2 through 5 show examples of two typical job executions in the Article/Book Maintenance System. Underlined text in the listings represents user input. Listing 2 shows an update file created with the North Star editor and saved under the name UPDATE1. The first job, shown in listing 3, is a sample run of the main program in the Article/Book Maintenance System. This run uses the file UPDATE1 to create a new master file, MASTER, then sorts and lists MASTER. Since no MASTER file existed when the job was set up, the program asks the user during the input dialogues of both the update/sort and the list commands to confirm that it's all right to proceed without MASTER.

Listing 4 shows the new update file, UPDATE2. The second run of the main program appears in listing 5. The dialogue in listing 5 causes MASTER to be updated with the data in UPDATE2, then sorted and listed by title, then sorted and listed by

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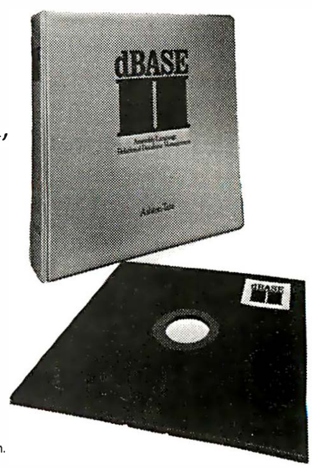
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author. The end of listing 5 shows both the system's listing by title and the listing by author. This simple example, which uses the same system of programs repeatedly to do a set of tasks and requires no attention from the operator after the job is set up, shows the convenience and flexibility of the executive of the Article/Book Maintenance system.

Programs

The Article/Book Maintenance System contains four programs. The main executive (MAIN) program handles all interaction between the Article/Book Maintenance System and the user. Handling the user interaction includes checking the validity of all input parameters. In addition, the MAIN program constructs a job-control file containing both the global data (to be used by all programs) and the parameters entered by the user to determine the course of program execution. MAIN provides a set of utility routines that can be used for the MAIN program in other batch-processing systems.

The subexecutive (%!) program reads the next entry in the job-control file to determine which program to call next for execution.

The update/sort (%!SORT) program performs updates and sorts. It reads global data from the job-control file and uses the data as parameters for the updates and sorts. The data read include parameters for listings (top and bottom margins, number of lines per page) and for adjusting the position of the paper after an error listing, the names of files to be sorted, and the field to use for the sort. After completing the update and the sort, this program returns control to the subexecutive.

The listing (%!LIST) program reads parameters from the job-control file, including the name of the master file to be listed and the order of fields for the listing.

Data Files

The Article/Book Maintenance System contains three kinds of data files. The job-control file (%!JCL) contains all the parameters and control information for the system. It is organized as a North Star Type 3 data file; figure 2 shows the file's format. Update files are defined by the user; they are files of North Star Type 2, which is normally used for BASIC programs. Master files, also user-defined, are files of North Star Type 3 as well.

File-naming conventions of the Article/Book Maintenance System are as follows: the MAIN program can have any name you wish, the subexecutive is %!, the job-control file is

Listing 1: *The formats for data in an update file for the Article/Book Maintenance system. These formats were chosen so that the North Star BASIC editor could be used for entering and deleting data in the batch-processing system.*

```
Add Entry

   line number"title\author\date"

       or

   line number"title\author\date\"


   Example:

   10"Art of Computer Programming - Fund. Alg. Vol I\Knuth, D.E.\1968"
   20"Compiler Design Theory\Lewis, P.M., et al\1976"

Delete Entry

   Same as add except for the addition of a minus sign between
   line numbers and the quote.  All master file entries whose fields
   match the fields specified in the delete entry will be deleted.
   In other words, one, two or all three fields may be used in making
   a match for deletion.

Example:

   10-"Erroneous Title\Author\1973"
```

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Listing 2: *The update file UPDATE1. This file is used in listing 3 to create a new master file.*

```
10"Art of Computer Programming - Fund. Alg. Vol I\Knuth, D.E.\1968"
20"Z80 Software Gourmet Guide & Cookbook\Wadsworth, N.\1979"
30"Basic with Style\Nagin, P, Ledgard, H\1978"
```

Listing 3: *A sample run of the MAIN program in the Article/Book Maintenance System. Underscored items are entries made by the user. The dialogue causes the system to create a new master file, sort it, and list it on the printer.*

```
SAMPLE MAIN

TYPE 'HELP' IN RESPONSE TO 'COMMAND:' IF YOU NEED DETAILED INSTRUCTION.
TO CANCEL ANY COMMAND JUST TYPE A 'RETURN' TO ANY INPUT REQUEST.

DATE: 01/05/81
TIME: 13:00
COMMAND: SORT
MASTER FILE NAME: MASTER
MASTER FILE DOESN'T EXIST.  IS THIS OKAY (Y/N)? Y
PROCESS UPDATE FILE (Y/N)? Y
UPDATE FILE NAME: UPDATE1
SORT BY TITLE, AUTHOR OR DATE (T/A/D)? T
COMMAND: LIST
MASTER FILE NAME: MASTER
MASTER FILE DOESN'T EXIST.  IS THIS OKAY (Y/N)? Y
EACH PRINT LINE WILL CONTAIN THE TITLE, AUTHOR AND DATE.
PLEASE SPECIFY THE ORDER TO PRINT.
ENTER 'T' FOR TITLE, 'A' FOR AUTHOR AND 'D' FOR DATE.
FIRST ONE: T
SECOND ONE: A
THIRD ONE: D
COMMAND: QUIT
...EXECUTING...UPDATE/SORT PROGRAM
...EXECUTING...LIST PROGRAM

----------Output on the printer:

ARTICLE/BOOK LIST          01/05/81  13:00                PAGE  1

TITLE                                              AUTHOR                DATE

Art of Computer Programming - Fund. Alg. Vol I     Knuth, D.E.           1968
Basic with Style                                   Nagin, P, Ledgard, H  1978
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RECORD LENGTH: **variable to 512,000 char.** (free format - no fixed length fields)
KEY WORDS PER SEARCH: **max. 64 using "and", "or" & "not"**
KEY WORDS PER DATA BASE: **max. 3,000 alpha-numeric plus 32,000 integers**
KEY WORDS PER RECORD: **max. 250**
KEY WORD LENGTH: **max. 64 char. each**
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%!JCL, and application-program files have names prefixed with %! (restricting the name to six characters).

Flow of Execution

Figure 3 shows the flow of execution of the Article/Book Maintenance System. The MAIN program executes first, then shifts to the subexecutive. The subexecutive determines whether the job is at an end. If not, the subexecutive determines, based on data from the job-control file, the next program to execute—whether %!SORT or %!LIST. Either the sort or the list program CHAINs to the subexecutive.

The MAIN Program

Listing 6 is the MAIN program. MAIN contains remarks identifying the functions and variables used. I'll comment on MAIN from beginning to end, with emphasis on use of the utility routines. I gave the utility routines line numbers from 64000 to 65040; this numbering should make it easy for you to use the delete and append features of BASIC to separate the utility routines and use them for another application. Now for the comments, by line number.

170–200 Drive Determination. A search determines the disk drive on which the Article/Book Maintenance System is located. This eliminates the need to specify the drive when running MAIN.

290–400 Command Interpretation. This block of code starts by determining the command. Line 300 calls a utility routine at line 64990 to check for null input. MAIN calls this routine to handle input throughout the program. The GOTOs on line 370 correspond to the functions defined in the DATA statement on line 100. In this case, 1000 is HELP, 2000 is QUIT, 3000 is SORT, and 4000 is LIST. The command-processing routine matches each character in the input string with each character in the commands defined in the DATA statement at 100. This permits the user to enter short forms for each command (H, Q, S, and L) and still identify the desired function in a unique manner.

1000–1130 HELP-Command Processing. These lines display the available commands as they were defined in the DATA statement at line 100.

2000–2030 QUIT-Command Processing. These lines close the job-control file and call the subexecutive.

3000–3500 SORT-Command Processing. Lines 3010-3030 start a new entry in the job-control file. The GOSUB 64260 goes to the utility routine that saves the name of the program to be executed. Line 3050 transfers control to the routine at 64460, which will add a descriptive phrase for the program to be executed. Lines 3070 and 3080 call utility routines to process

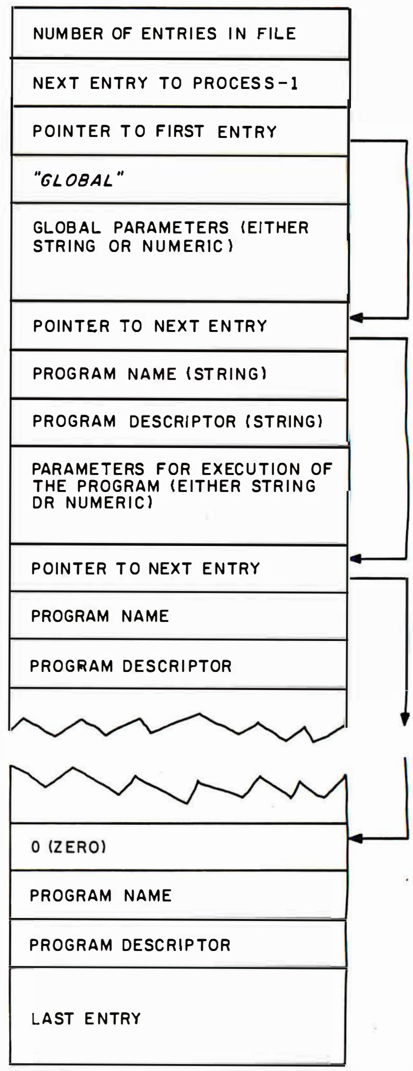


Figure 2: *The structure of the job-control file. The file contains "global" parameters—parameters needed by more than one program in the Article/Book Maintenance System—and the parameters that determine which program is executed next.*

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file-name inputs. Two additional utility routines, found at lines 64460 and 64360, are called to process string and numeric values respectively. Whenever the routine at line 64990 is called to check for null input (e.g., line 3110), the jump for null value indicated on the next statement (e.g., line 3120) goes to 65050 to reset the pointers for starting the entry over. To complete command processing, line 3490 calls the routine at 64150 to update the pointers in the job-control file.

4000–4570 LIST-Command Processing. Setting up an entry in the job-control file requires the same kind of processing required in the SORT command. The first and last lines of the code for each command that adds an entry to the job-control file are the same, as shown here:

P1=P (start of command processing)

Text continued on page 366

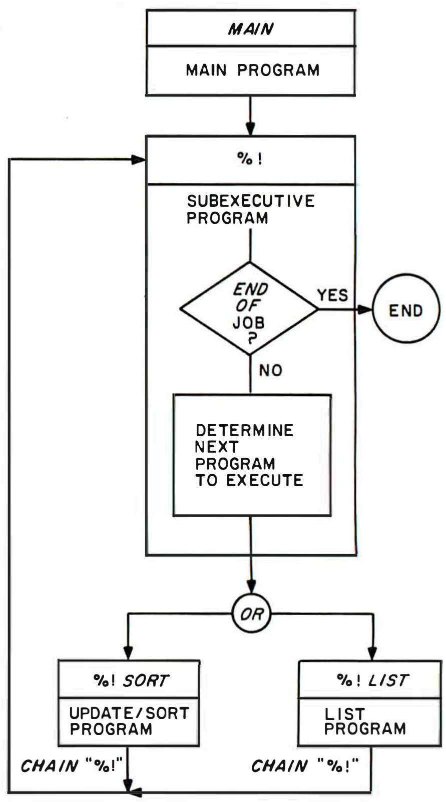


Figure 3: *A diagram of control flow in the Article/Book Maintenance System. The main program executes first and calls the subexecutive. Based on data from the job-control file, the subexecutive determines which program executes next.*

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Listing 4: *The update file UPDATE2. Line 20 deletes an old entry and replaces it with the data in line 30. The dialogue in listing 5 shows how the Article/Book Maintenance System incorporates UPDATE2 in a new master file.*

```
10"Pascal - User Manual & Report\Jensen, K, Wirth, N\1974"
20-"Basic with Style\\"
30"Basic with Style - Programming Proverbs\Nagin, P, Ledgard, H\1978"
```

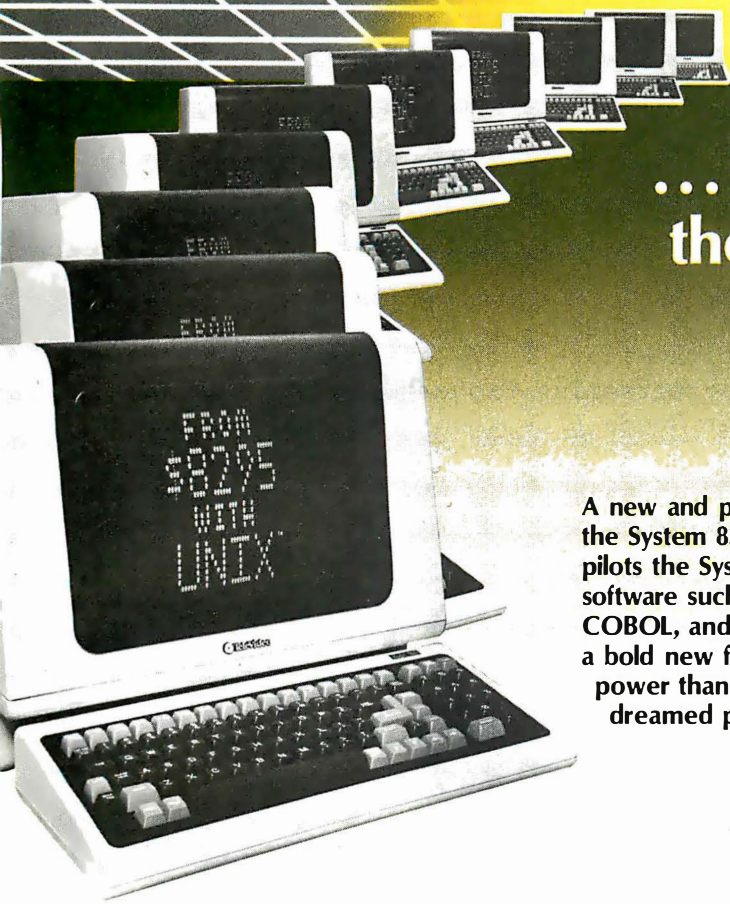
Listing 5: *A second sample run of the MAIN program in the Article/Book Maintenance System. Underscored items are entries made by the user. The dialogue causes the system to update the master file, sort and list it by title, then sort and list it by author. Both sets of sorted data appear at the end of the listing.*

```
SAMPLE MAIN

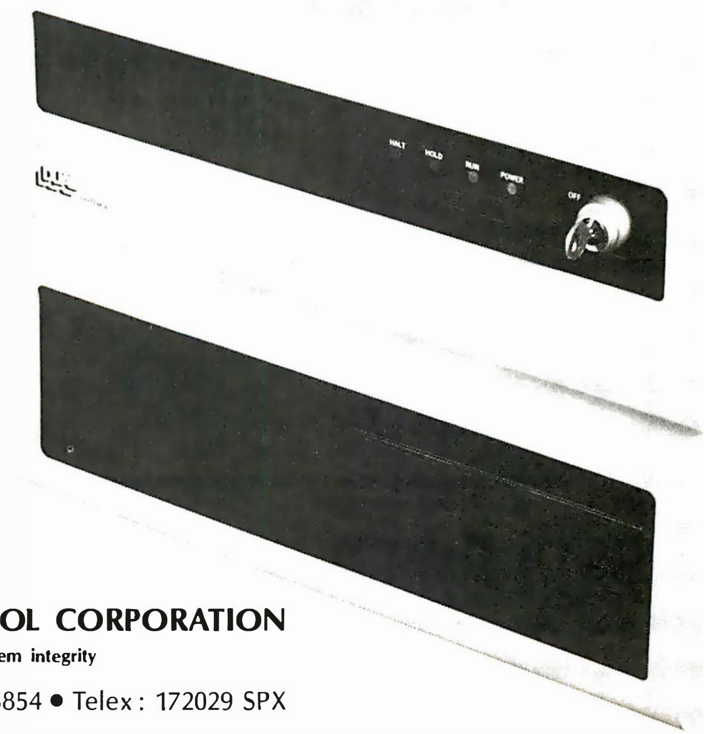
TYPE 'HELP' IN RESPONSE TO 'COMMAND:' IF YOU NEED DETAILED INSTRUCTIONS.
TO CANCEL ANY COMMAND JUST TYPE A 'RETURN' TO ANY INPUT REQUEST.

DATE: 01/06/81
TIME: 09:00
COMMAND: SORT
MASTER FILE NAME: MASTER
PROCESS UPDATE FILE (Y/N)? Y
UPDATE FILE NAME: UPDATE2
SORT BY TITLE, AUTHOR OR DATE (T/A/D)? T
COMMAND: LIST
MASTER FILE NAME: MASTER
EACH PRINT LINE WILL CONTAIN THE TITLE, AUTHOR & DATE.
PLEASE SPECIFY THE ORDER TO PRINT.
ENTER 'T' FOR TITLE, 'A' FOR AUTHOR AND 'D' FOR DATE.
FIRST ONE? T
SECOND ONE? A
THIRD ONE? D
COMMAND: SORT
MASTER FILE NAME: MASTER
PROCESS UPDATE FILE (Y/N)? N
SORT BY TITLE, AUTHOR OR DATE (T/A/D)? A
COMMAND: LIST
MASTER FILE NAME: MASTER
EACH PRINT LINE WILL CONTAIN THE TITLE, AUTHOR AND DATE.
PLEASE SPECIFY THE ORDER TO PRINT.
ENTER 'T' FOR TITLE, 'A' FOR AUTHOR AND 'D' FOR DATE.
FIRST ONE? A
SECOND ONE? T
THIRD ONE? D
COMMAND: QUIT
...EXECUTING...UPDATE/SORT PROGRAM
...EXECUTING...LIST PROGRAM
...EXECUTING...UPDATE/SORT PROGRAM
...EXECUTING...LIST PROGRAM
```

Listing 5 continued on page 352



FROM
$8295
WITH
UNIX



HALT
HOLD
RUN
POWER
OFF

Listing 5 continued:

```
 -----------------Output on the printer:

 ARTICLE/BOOK LIST          01/06/81   09:00                      PAGE   1

 TITLE                                                AUTHOR               DATE

 Art of Computer Programming - Fund. Alg. Vol I       Knuth, D.E.          1968
 Basic with Style - Programming Proverbs              Nagin, P, Ledgard, H 1978
 Pascal - User Manual & Report                        Jensen, K, Wirth, N  1974
 Z80 Software Gourmet Guide & Cookbook                Wadsworth, N.        1979

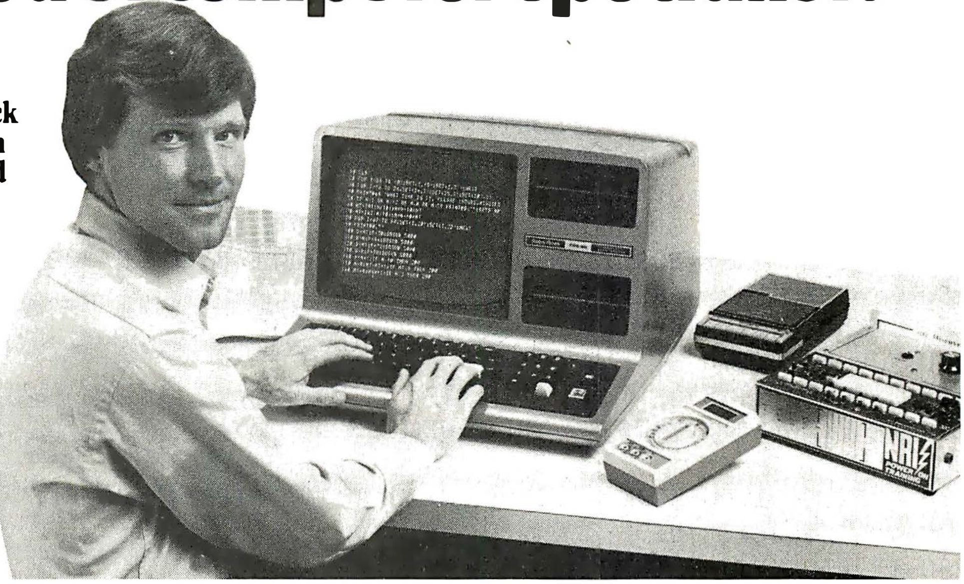
          ...

 ARTICLE/BOOK LIST          01/06/81   09:00                      PAGE   1

 AUTHOR               TITLE                                                DATE

 Jensen, K, Wirth, N  Pascal - User Manual & Report                        1974
 Knuth, D.E.          Art of Computer Programming - Fund. Alg. Vol I       1968
 Nagin, P, Ledgard, H Basic with Style - Programming Proverbs              1978
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Listing 6: *The MAIN program in the Article/Book Maintenance System. This program is the executive that manages the other programs. It handles all interaction with the user and sets up a job-control file. MAIN repeatedly calls the utility subroutines found at lines 64000 through 65040.*

```
10 REM* MAIN EXECUTIVE (SAVED IN FILE "MAIN")
20 REM* 12/16/80  WRITTEN BY GENE F. WALTERS
30 REM* SET UP PARAMETERS
40 DIM V$(80)
50 D1=0 \REM DEVICE FOR CONSOLE
60 D3=0 \REM DISK FILE FOR THE SYSTEM
70 U=3 \REM NO. OF DRIVES IN SYSTEM
80 L1=5 \REM NO. OF BYTES FOR NUMERIC VALUES
90 L2=2 \REM NO. OF BYTES OF OVERHEAD FOR A STRING < 256 CHAR
100 DATA "HELP","QUIT","SORT","LIST" \REM AVAILABLE COMMANDS
110 N9=4 \REM NO. OF COMMANDS THAT CAN BE EXECUTED
120 N=0 \REM NO. OF COMMANDS IN JOB CONTROL FILE
130 B=5 \REM NO. OF BLOCKS FOR JOB CONTROL FILE
140 P=L1+L1 \REM POSITION OF NEXT AVAILABLE BYTE IN JOB CONTROL FILE
150 S$="%!" \REM PREFIX FOR SYSTEM FILE NAMES
160 GOSUB 64520 \REM SIGN-ON MESSAGE
170 FOR I=1 TO U
180 U$=CHR$(I+48)
190 IF FILE(S$+","+U$)=2 THEN  EXIT 220
200 NEXT I
210 PRINT #D1,"COULDN'T FIND SUBEXECUTIVE FILE [",S$,"]." \END
220 F$=S$+"JCL,"+U$
230 IF FILE(F$)=3 THEN 250
240 CREATE F$,B
250 OPEN #D3,F$
260 WRITE #D3,N,0
270 GOSUB 5000 \REM SET UP GLOBAL PARAMETERS IN JOB CONTROL FILE
280 REM* INPUT NEXT COMMAND
290 RESTORE \INPUT #D1,"NEXT COMMAND: ",C1$
300 I$=C1$ \GOSUB 64990 \REM CHECK FOR NULL INPUT
310 ON Z GOTO 320, 290
320 FOR I=1 TO N9
330 READ C2$
340 IF LEN(C1$)>LEN(C2$) THEN 380
350 IF C1$<>C2$(1,LEN(C1$)) THEN 380
360 N=N+1
370 ON I GOTO 1000, 2000, 3000, 4000 \REM  GOTO FOR EACH COMMAND
380 NEXT I
390 PRINT #D1,"INVALID COMMAND!"
400 GOTO 290
1000 REM* HELP COMMAND
1010 RESTORE
1020 PRINT #D1
1030 PRINT #D1,"COMMANDS AVAILABLE: ",
1040 FOR I=1 TO INT((N9+5)/6)
1050 FOR J=1 TO N9-INT(N9/6)*6
1060 READ C2$
1070 PRINT #D1,C2$,
1080 IF (I-1)*6+J<>N9 THEN PRINT #D1,", ",
1090 NEXT J
1100 PRINT #D1 \PRINT #D1,TAB(20),
```

Listing 6 continued on page 356

Listing 6 continued:

```
1110 NEXT I
1120 PRINT #D1
1130 GOTO 290
2000 REM* QUIT COMMAND
2010 WRITE #D3%P,0
2020 CLOSE #D3
2030 CHAIN S$+A$+","+U$
3000 REM* SORT COMMAND
3010 P1=P \REM SAVE CURRENT POSITION OF BYTE POINTER
3020 P$=S$+"SORT"+A$+","+U$
3030 GOSUB 64260 \REM SAVE BYTE COUNTER & PROGRAM NAME TO EXEC
3040 V$="UPDATE/SORT PROGRAM"
3050 GOSUB 64460 \REM ADD STRING PARAMETER FOR PROGRAM DESCRIPTOR
3060 PRINT #D1,"MASTER ",
3070 GOSUB 64870 \REM GET FILE NAME
3080 GOSUB 64670 \REM SEPARATE OUT UNIT & CHECK FOR EXISTENCE
3090 ON Z GOTO 3170, 3100
3100 INPUT #D1,"MASTER FILE DOESN'T EXIST.  IS THIS OKAY (Y/N)? ",X$
3110 I$=X$ \GOSUB 64990 \REM CHECK FOR NULL INPUT
3120 ON Z GOTO 3130, 65050
3130 IF X$="Y" THEN 3170
3140 IF X$="y" THEN 3170
3150 IF X$="N" THEN 65050
3160 IF X$="n" THEN 65050 ELSE 3100
3170 V$=F1$ \GOSUB 64460 \REM ADD STRING PARAMETER F1$, MASTER FILE NAME
3180 V$=F2$ \GOSUB 64460 \REM ADD STRING PARAMETER F2$, MASTER UNIT NO.
3190 INPUT #D1,"PROCESS UPDATE FILE (Y/N)? ",X$
3200 I$=X$ \GOSUB 64990 \REM CHECK FOR NULL INPUT
3210 ON Z GOTO 3220, 65050
3220 IF X$="Y" THEN 3290
3230 IF X$="y" THEN 3290
3240 IF X$="N" THEN 3260
3250 IF X$<>"n" THEN 3190
3260 V$="" \GOSUB 64460 \REM ADD NULL STRING FOR UPDATE FILENAME
3270 GOSUB 64460 \REM ADD NULL STRING FOR UPDATE UNIT NO.
3280 GOTO 3370
3290 PRINT #D1,"UPDATE ",
3300 GOSUB 64870 \REM GET FILE NAME
3310 GOSUB 64670 \REM SEPARATE OUT UNIT & CHECK FOR EXISTENCE
3320 ON Z GOTO 3350, 3330
3330 F9$=F$ \GOSUB 64800 \REM COULDN'T FIND FILE
3340 GOTO 65050
3350 V$=F1$ \GOSUB 64460 \REM ADD STRING PARAMETER F1$, UPDATE FILE NAME
3360 V$=F2$ \GOSUB 64460 \REM ADD STRING PARAMETER F2$, UPDATE UNIT NO.
3370 V=0
3380 INPUT #D1,"SORT BY TITLE, AUTHOR OR DATE (T/A/D)? ",X$
3390 I$=X$ \GOSUB 64990 \REM CHECK FOR NULL INPUT
3400 ON Z GOTO 3410, 65050
3410 IF X$="T" THEN V=1
3420 IF X$="t" THEN V=1
3430 IF X$="A" THEN V=2
3440 IF X$="a" THEN V=2
3450 IF X$="D" THEN V=3
3460 IF X$="d" THEN V=3
```

Listing 6 continued on page 358

Listing 6 continued:

```
3470 IF V=0 THEN 3380
3480 GOSUB 64360 \REM ADD NUMERIC PARAMETER, SORT OPTION
3490 GOSUB 64150 \REM UPDATE NO. OF COMMAND ENTRIES
3500 GOTO 290
4000 REM* LIST COMMAND
4010 P1=P \REM SAVE CURRENT POSITION OF BYTE POINTER
4020 P$=S$+"LIST"+A$+","+U$
4030 GOSUB 64260 \REM SAVE BYTE COUNTER & PROGRAM NAME TO EXEC
4040 V$="LIST PROGRAM"
4050 GOSUB 64460 \REM ADD STRING PARAMETER FOR PROGRAM DESCRIPTOR
4060 PRINT #D1,"MASTER ",
4070 GOSUB 64870 \REM GET FILE NAME
4080 GOSUB 64670 \REM SEPARATE OUT UNIT & CHECK FOR EXISTENCE
4090 ON Z GOTO 4170, 4100
4100 INPUT #D1,"MASTER FILE DOESN'T EXIST.  IS THIS OKAY (Y/N)? ",X$
4110 I$=X$ \GOSUB 64990 \REM CHECK FOR NULL INPUT
4120 ON Z GOTO 4130, 65050
4130 IF X$="Y" THEN 4170
4140 IF X$="y" THEN 4170
4150 IF X$="N" THEN 65050
4160 IF X$="n" THEN 65050 ELSE 4100
4170 V$=F1$ \GOSUB 64460 \REM ADD STRING PARAMETER F1$, MASTER FILE NAME
4180 V$=F2$ \GOSUB 64460 \REM ADD STRING PARAMETER F2$, MASTER UNIT NO.
4190 PRINT #D1,"EACH PRINT LINE WILL CONTAIN THE TITLE, AUTHOR & DATE."
4200 PRINT #D1,"PLEASE SPECIFY THE ORDER TO PRINT."
4210 PRINT #D1,"ENTER 'T' FOR TITLE, 'A' FOR AUTHOR AND 'D' FOR DATE."
4220 INPUT #D1,"FIRST ONE? ",B$
4230 I$=B$ \GOSUB 64950 \REM CHECK FOR NULL INPUT
4240 ON Z GOTO 4250, 65010
4250 GOSUB 4490 \REM CONVERT B$ TO 1=T, 2=A, 3=D, 4=NONE
4260 B1=Z
4270 ON Z GOTO 4280, 4280, 4280, 4220
4280 INPUT #D1,"SECOND ONE? ",B$
4290 I$=B$ \GOSUB 64950 \REM CHECK FOR NULL INPUT
4300 ON Z GOTO 4310, 65010
4310 GOSUB 4490 \REM CONVERT B$ TO 1=T, 2=A, 3=D, 4=NONE
4320 B2=Z
4330 ON Z GOTO 4340, 4340, 4340, 4280
4340 IF B2=B1 THEN 4470
4350 INPUT #D1,"THIRD ONE? ",B$
4360 I$=B$ \GOSUB 64950 \REM CHECK FOR NULL INPUT
4370 ON Z GOTO 4380, 65010
4380 GOSUB 4490 \REM CONVERT B$ TO 1=T, 2=A, 3=D, 4=NONE
4390 B3=Z
4400 ON Z GOTO 4410, 4410, 4410, 4350
4410 IF B3=B1 OR B3=B2 THEN 4470
4420 V=B1 \GOSUB 64360 \REM ADD NUMERIC PARAMETER B1, 1ST PRINT FIELD
4430 V=B2 \GOSUB 64360 \REM ADD NUMERIC PARAMETER B2, 2ND PRINT FIELD
4440 V=B3 \GOSUB 64360 \REM ADD NUMERIC PARAMETER B3, 3RD PRINT FIELD
4450 GOSUB 64150 \REM UPDATE NO. OF COMMAND ENTRIES
4460 GOTO 290
4470 PRINT #D1,"INPUT ERROR.  PLEASE START OVER."
4480 GOTO 4220
4490 REM SUBROUTINE TO CONVERT B$ TO 1=T, 2=A, 3=D, 4=NONE
```

Listing 6 continued on page 360



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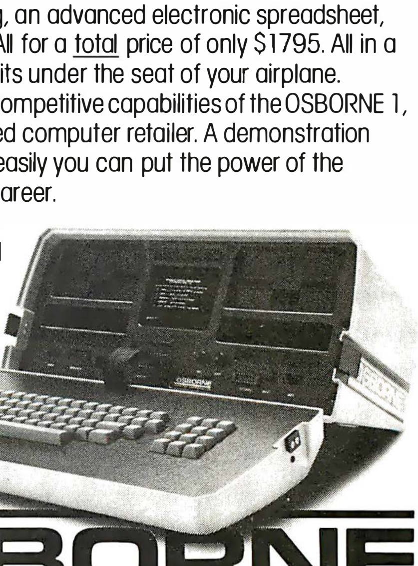
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Listing 6 continued:

```
4500 Z=4
4510 I$=B$ \GOSUB 64990 \REM CHECK FOR NULL INPUT
4520 ON Z GOTO 4530, 65050
4530 IF B$="T" THEN Z=1
4540 IF B$="t" THEN Z=1
4550 IF B$="A" THEN Z=2
4560 IF B$="a" THEN Z=2
4570 IF B$="D" THEN Z=3
4580 IF B$="d" THEN Z=3
4590 RETURN
5000 REM*-------------------
5010 REM* SUBROUTINE TO SET UP GLOBAL PARAMETERS
5020 REM*-------------------
5040 P$="GLOBAL"
5050 GOSUB 64260 \REM SAVE BYTE COUNTER & ENTRY ID
5060 INPUT #D1,"DATE: ",D$
5070 INPUT #D1,"TIME: ",T$
5080 V$=D$ \GOSUB 64460 \REM ADD STRING PARAMETER D$, DATE
5090 V$=T$ \GOSUB 64460 \REM ADD STRING PARAMETER T$, TIME
5100 V=66 \REM NO. OF LINES PER OUTPUT PAGE
5110 GOSUB 64360 \REM ADD NUMERIC PARAMETER IN V
5120 V=2 \REM NO. OF LINES FOR TOP MARGIN
5130 GOSUB 64360 \REM ADD NUMERIC PARAMETER IN V
5140 V=3 \REM NO. OF LINES FOR BOTTOM MARGIN
5150 GOSUB 64360 \REM ADD NUMERIC PARAMETER IN V
5160 V=48 \REM MAX LENGTH OF TITLE
5170 GOSUB 64360 \REM ADD NUMERIC PARAMETER IN V
5180 V=20 \REM MAX LENGTH OF AUTHOR
5190 GOSUB 64360 \REM ADD NUMERIC PARAMETER IN V
5200 V=10 \REM MAX LENGTH OF DATE
5210 GOSUB 64360 \REM ADD NUMERIC PARAMETER IN V
5220 WRITE #D3%L1+L1,P,NOENDMARK \REM UPDATE BYTE POINTER
5230 RETURN
64000 REM#-------------------
64010 REM*-------------------
64020 REM* SUPPORTING ROUTINES
64030 REM*-------------------
64040 REM*-------------------
64050 REM
64060 REM*-------------------
64070 REM* SUBROUTINE TO UPDATE THE NUMBER OF COMMAND ENTRIES IN THE JCL
64080 REM*    FILE AND SET UP THE POINTER TO THE NEXT COMMAND ENTRY
64090 REM*-------------------
64100 REM
64110 REM* VARIABLES USED BY ROUTINE -
64120 REM*    N  - CURRENT COUNT FOR NUMBER OF COMMAND ENTRIES
64130 REM*    P1 - BYTE POSITION OF POINTER TO NEXT COMMAND ENTRY
64140 REM*    P  - BYTE POSITION OF FIRST BYTE OF NEXT COMMAND ENTRY
64150 WRITE #D3%0,N,NOENDMARK
64160 WRITE #D3%P1,P,NOENDMARK
64170 RETURN
64180 REM*-------------------
64190 REM* SUBROUTINE TO SAVE CURRENT BYTE POINTER AND PROGRAM NAME TO
64200 REM*    EXECUTE IN CURRENT COMMAND ENTRY IN THE JCL FILE
```

Listing 6 continued on page 362

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Listing 6 continued:

```
64210 REM*--------------------
64220 REM
64230 REM* VARIABLES USED BY ROUTINE -
64240 REM*    P$ - NAME OF PROGRAM TO EXECUTE (INCLUDES UNIT NUMBER)
64250 REM*    P  - BYTE COUNTER FOR JCL FILE
64260 WRITE #D3%P,P,P$
64270 P=P+L1+LEN(P$)+L2
64280 RETURN
64290 REM*--------------------
64300 REM* SUBROUTINE TO ADD A NUMERIC PARAMETER TO A COMMAND ENTRY
64310 REM*--------------------
64320 REM
64330 REM* VARIABLES USED BY ROUTINE -
64340 REM*    V - NUMERIC VALUE TO ADD
64350 REM*    P - BYTE COUNTER FOR JCL FILE
64360 WRITE #D3,V
64370 P=P+L1
64380 RETURN
64390 REM*--------------------
64400 REM* SUBROUTINE TO ADD A STRING PARAMETER TO A COMMAND ENTRY
64410 REM*--------------------
64420 REM
64430 REM*  VARIABLES USED BY ROUTINE -
64440 REM*    V$ - STRING VALUE TO ADD
64450 REM*    P  - BYTE COUNTER FOR JCL FILE
64460 WRITE #D3,V$
64470 P=P+LEN(V$)+L2
64480 RETURN
64490 REM*--------------------
64500 REM* SUBROUTINE TO DISPLAY INITIAL SIGN-ON MESSAGES
64510 REM*--------------------
64520 PRINT #D1,"SAMPLE MAIN" \PRINT #D1
64530 PRINT #D1,"TYPE 'HELP' IN RESPONSE TO 'COMMAND:' IF YOU ",
64540 PRINT #D1,"NEED DETAILED INSTRUCTION."
64550 PRINT #D1,"TO CANCEL ANY COMMAND JUST TYPE A 'RETURN'",
64560 PRINT #D1," TO ANY INPUT REQUEST."
64570 PRINT #D1
64580 RETURN
64590 REM*--------------------
64600 REM* SUBROUTINE TO REMOVE UNIT NO. FROM FILE NAME
64610 REM*--------------------
64620 REM
64630 REM* USES         F$  - FILE NAME WITH UNIT NO.
64640 REM* RETURNS      F1$ - FILE NAME
64650 REM*              F2$ - UNIT IN THE FORM ',X'
64660 REM*              Z   - 1 FOR FILE EXISTS, 2 IF IT DOESN'T
64670 IF FILE(F$)=-1 THEN Z=2 ELSE Z=1
64680 F1$=F$
64690 F2$=",1"
64700 FOR I=1 TO LEN(F$)
64710 IF F$(I,I)<>"," THEN 64730
64720 F1$=F$(1,I-1) \F2$=F$(I) \EXIT 64740
64730 NEXT I
64740 RETURN
64750 REM*--------------------
```

Listing 6 continued on page 364



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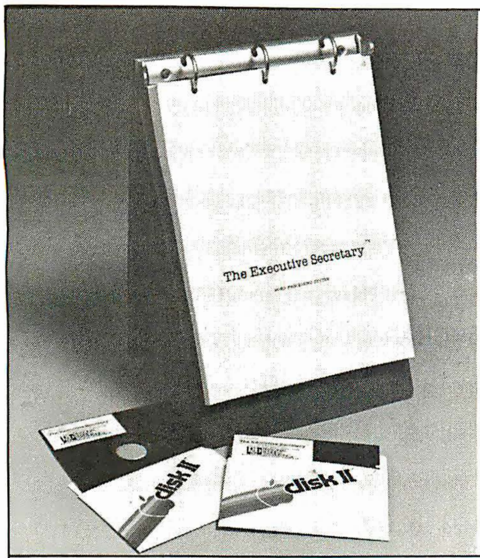
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Listing 6 continued:

```
64760 REM* SUBROUTINE FOR FILE ERROR MESSAGE
64770 REM*------------------
64780 REM
64790 REM* USES    F9$ - FILE NAME
64800 PRINT #D1,"COULDN'T FIND FILE ",F9$
64810 RETURN
64820 REM*------------------
64830 REM* SUBROUTINE FOR REQUESTING FILE NAME
64840 REM*------------------
64850 REM
64860 REM* RETURNS FILE NAME IN F$
64870 INPUT #D1,"FILE NAME: ",F$
64880 I$=F$
64890 GOSUB 64990 \REM CHECK FOR NULL INPUT
64900 ON Z GOTO 64910, 65050
64910 RETURN
64920 REM*------------------
64930 REM* CHECK FOR NULL STRING
64940 REM*------------------
64950 REM
64960 REM* USES         I$ WHICH CONTAINS THE INPUT STRING TO CHECK
64970 REM* RETURNS      Z = 1 IF THE LEN(I$)>0
64980 REM*                  2 IF THE LEN(I$)=0
64990 Z=1
65000 IF I$="" THEN Z=2
65010 RETURN
65020 REM*------------------
65030 REM* BACKUP FILE POINTER TO BEGINNING OF ENTRY
65040 REM*------------------
65050 READ #D3%P1-1,&Z \REM READ TO POSITION PTR AT P1
65060 P=P1 \REM BACKUP RUNNING BYTE COUNTER
65070 N=N-1 \REM BACKUP ENTRY COUNTER
65080 GOTO 290
```



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Listing 7: *The subexecutive program (%!). This reads the next entry in the job-control file and determines which program to call next.*

```
10 REM* SUBEXECUTIVE (SAVED IN FILE %!)
20 REM* 11/11/80
25 DIM P$(80)
30 D1=0 \REM DEVICE FOR CONSOLE
40 D3=0 \REM DISK DRIVE FOR SYSTEM
41 L1=5 \REM NO. OF BYTES FOR NUMERIC VALUES
42 L2=2 \REM NO. OF OVERHEAD BYTES FOR A STRING < 256 CHAR
43 S$="%!" \REM PREFIX FOR SYSTEM FILE NAMES
50 FOR I=1 TO 3
60 U$=CHR$(I+48)
70 IF FILE(S$+"JCL,"+U$)=3 THEN EXIT 100
80 NEXT I
90 PRINT #D1,"COULDN'T FIND JOB CONTROL FILE." \END
100 OPEN #D3,S$+"JCL,"+U$
110 READ #D3,N,N0,N1
120 IF N0=N THEN END
130 P=N1 \REM NO. OF BYTES FOR N+N0
140 FOR I=0 TO N0
150 READ #D3%P,P1
160 P=P1
170 NEXT I
180 READ #D3,X$,P$
190 WRITE #D3%L1,N0+1,NOENDMARK
195 PRINT #D1,"...EXECUTING...",P$
200 CHAIN X$
```

Text continued from page 348:

```
P$=S$+(program name)+
  A$+","+U$
GOSUB 64260
V$=(program description)
GOSUB 64460
        .
        .
        .
GOSUB 64360
GOTO 290        (end of command
                processing)
```

5000–5230 Setting Up Global Parameters. These lines repeatedly call utility routines to put parameters common to all programs into the job-control file. Since the code does not evaluate the date and time variables, D$ and T$, the user can input date and time in any form so long as the entries are ten characters or fewer in length.

The Subexecutive

Listing 7 is the subexecutive (%!) program. Since the subexecutive's only functions are to read the next entry in the job-control file and transfer control to the program indicated by that file, the subexecutive is independent of application. Here are comments, by line number, on the subexecutive.

50–80 Drive Determination. The subexecutive searches for the disk drive that contains the job-control file.

100–110 Read Initial Job-Control Parameters. These lines read the number of entries in the file (N), the last entry processed (N0), and the pointer giving the byte position (N1).

130–180 Read Name of Program for CHAINing. The first parameter of each entry is the pointer to the next entry, except in the case of the last entry, whose first parameter is set to 0. This program segment exploits North Star BASIC's direct addressing of disk files for positioning and reading parameters at the correct byte. This segment also reads the name of the program, X$, and the descriptive phrase about the program, P$.

190 Update the Entry Counter. This updates the entry counter (the second parameter in the file) by 1, so that it points to the next entry to be processed.

195–200 Transfer Control to Next Program. These lines display on the console a message that tells which program is running and then CHAIN the next program.

The Update/Sort Program

Listing 8 is the update/sort (%!SORT) program. I will describe only those features of this program that relate to its overall structure and its use of the executive.

30–90 Overall Program Flow. These lines all call subroutines. The simplest way to develop a program for execution in this system is to call a series of subroutines, each of which performs a major function. This allows isolation of the part of the program at lines 1000, 2000, and 7000 that interfaces with the executive and the job-control file. The other subroutines at lines 3000, 4000, 5000, and 6000 actually do the updating and sorting.

1000–1270 Read in Global Data. This section of code dimensions arrays, initializes variables, and reads in the

Text continued on page 378

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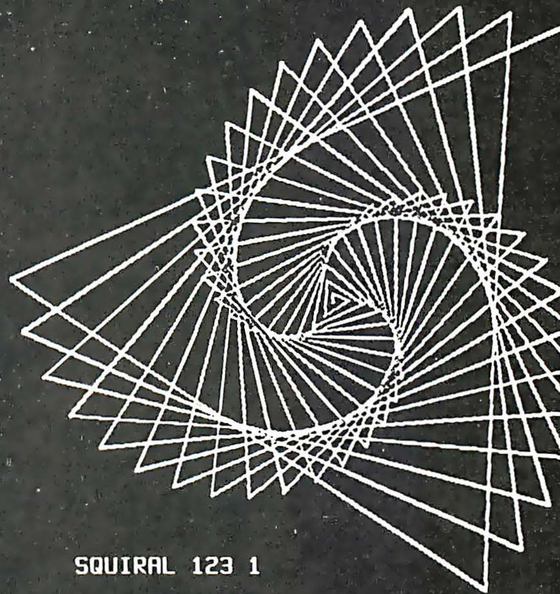
Circle 254 on inquiry card.

Listing 8: *The update/sort program (%!SORT). Lines 30 through 90 control the flow of the program by calling seven subroutines—one for each major program function.*

```
10 REM* SAMPLE SORT PROGRAM (SAVED IN FILE '%!SORT')
20 REM* 12/16/80 WRITTEN BY GENE F. WALTERS
30 GOSUB 1000 \REM READ IN GLOBAL DATA
40 GOSUB 2000 \REM READ IN SORT COMMAND DATA
50 GOSUB 3000 \REM READ IN MASTER FILE
60 GOSUB 4000 \REM READ UPDATE FILE AND MERGE WITH MASTER DATA
70 GOSUB 5000 \REM SORT MERGED DATA
80 GOSUB 6000 \REM WRITE OUT NEW MASTER FILE
90 GOSUB 7000 \REM RETURN TO SUBEXECUTIVE
1000 REM*------------------
1010 REM* SUBROUTINE TO READ IN GLOBAL DATA
1020 REM*------------------
1030 DIM P$(80)
1040 D1=0 \REM DEVICE FOR CONSOLE
1050 D2=1 \REM DEVICE FOR PRINTER
1060 D3=0 \REM DISK FILE FOR THE SYSTEM
1070 D4=1 \REM MASTER FILE
1080 D5=2 \REM UPDATE FILE
1090 U=3 \REM NO. OF DRIVES IN SYSTEM
1100 S$="%!" \REM PREFIX FOR SYSTEM FILE NAMES
1110 FOR I=1 TO U
1120 U$=CHR$(I+48)
1130 IF FILE(S$+"JCL,"+U$)=3 THEN EXIT 1160
1140 NEXT I
1150 PRINT #D1,"COULDN'T FIND JOB CONTROL FILE." \END
1160 OPEN #D3,S$+"JCL,"+U$
1170 READ #D3,N,N0,N1 \REM-# CMD ENTRIES, CURRENT CMD, PTR TO 1ST ENTRY
1180 READ #D3,P$ \REM PASS OVER FIRST STRING
1190 READ #D3,D$,T$ \REM READ IN DATE AND TIME
1200 READ #D3,P5,P6,P7 \REM LINES/PAGE, TOP MARGIN, BOTTOM MARGIN
1210 READ #D3,K1,K2,K3 \REM MAX LENGTH FOR TITLE, AUTHOR, DATE
1220 K9=K1+K2+K3
1230 DIM E$(125*K9),X$(K9+3),A(132),E1$(K1),E2$(K2),E3$(K3)
1240 DIM Q$(K9),Q0$(K9),B$(K9),B0$(K9)
1250 P=0 \REM PAGE COUNTER
1260 L=0 \REM LINE COUNTER
1270 RETURN
2000 REM*------------------
2010 REM* SUBROUTINE TO READ IN SORT COMMAND DATA
2020 REM*------------------
2030 P2=N1
2040 FOR I=1 TO N0
2050 P1=P2
2060 READ #D3%P1,P2
2070 NEXT I
2080 READ #D3,P$,P$ \REM PASS OVER FIRST TWO STRINGS
2090 READ #D3,F1$,U1$ \REM FILE NAME & UNIT FOR MASTER
2100 READ #D3,F2$,U2$ \REM FILE NAME & UNIT FOR UPDATES
2110 READ #D3,M \REM FIELD TO SORT ON
2120 CLOSE #D3
2130 RETURN
3000 REM*------------------
```

Listing 8 continued on page 370

The Logo Language is Here for the Apple II



```
TO SQUIRAL :ANGLE :DISTANCE
 IF :DISTANCE > 200 THEN STOP
 FORWARD :DISTANCE
 RIGHT :ANGLE
 SQUIRAL :ANGLE :DISTANCE + 3
END
```

```
SQUIRAL 123 1
```

Terrapin, the Turtle Company, brings you the Terrapin Logo Language for the Apple II with Turtle graphics, now ready for immediate delivery.

The Terrapin Logo language is a sophisticated and powerful language that is easy for anyone to use. Although originally intended for children, the Logo language is one that the most advanced programmers will enjoy using too. It includes many features common to artificial intelligence research languages permitting programs of great power to be written quickly and easily. Writing comparable programs in other languages is usually much more difficult and time consuming.

The Turtle graphics is fun and easy. With simple commands such as FORWARD, RIGHT, and PENUP you can draw in six hi-res colors. In just a few short sessions you can learn to create figures more complex than the one above whether you know how to program or not.

But the Terrapin Logo language is more than just a graphics language. It supports:

- list structure, allowing easy manipulation of words (strings) and lists
- user defined procedures which can be used exactly as if they were part of the language.
- fully integrated screen editor for procedures and text
- floating point and integer arithmetic
- a total of 120 primitives (commands) including 30 graphics commands
- recursion
- assembly-language interface capability

The Terrapin Logo language was developed by the Artificial Intelligence lab at the Massachusetts Institute of Technology. Terrapin is now authorized by MIT to distribute the results of its 12 years of research to you. To provide quality support for the language, Terrapin has assembled a team that includes two of the three authors who developed the Logo language for the Apple II at MIT, as well as Dr. Feurzeig, the originator of the Logo language.

Every copy of the Terrapin Logo language comes with complete documentation. To run the language, a 48K Apple II with a 16K RAM card or a language card, and one disk drive is required.

Terrapin also offers the robot Turtle, and the following books: *Turtle Geometry, Special Technology for Special Children, Mindstorms, Katie & the Computer,* and *Apple Logo* from Byte Books.

Suggested retail price: $149.95
To order or for more information, call or write:

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678 Massachusetts Avenue
Cambridge, MA 02139
(617) 492-8816

```
3010 REM* SUBROUTINE TO READ MASTER FILE
3020 REM*-------------------
3030 E=0 \REM NO. OF ENTRIES
3040 E$="" \REM STRING ARRAY FOR ENTRIES
3050 IF FILE(F1$+U1$)<>3 THEN RETURN
3060 OPEN #D4,F1$+U1$
3070 IF TYP(D4)=0 THEN 3120
3080 READ #D4,E1$,E2$,E3$
3090 E$=E$+E1$+E2$+E3$
3100 E=E+1
3110 GOTO 3070
3120 CLOSE #D4
3130 RETURN
4000 REM*-------------------
4005 REM* SUBROUTINE TO READ UPDATE FILE
4010 REM*-------------------
4015 IF F2$="" THEN RETURN
4020 OPEN #D5%2,F2$+U2$
4025 READ #D5,&A(1) \REM READ # OF BYTES IN LINE
4030 IF A(1)=1 THEN 4355 \REM END OF BASIC TYPE 2 FILE
4035 FOR I=2 TO A(1) \REM READ IN BASIC LINE
4040 READ #D5,&A(I)
4045 NEXT I
4050 X$="" \REM INITIALIZE STRING FORM OF BASIC LINE
4055 S=0 \REM SET S TO INDICATE ADD ENTRY OPERATION
4060 FOR I=4 TO A(1)-1
4065 IF A(I)=34 THEN EXIT 4085 \REM SEARCH FOR QUOTE
4070 IF A(I)=229 THEN S=1 \REM SET S TO INDICATE DELETE ENTRY
4075 NEXT I
4080 GOTO 4340
4085 J1=I+1
4090 FOR I=A(1)-1 TO J1 STEP -1 \IF A(I)=34 THEN EXIT 4100 \NEXT I
4095 GOTO 4340
4100 J2=I-1
4105 FOR I=J1 TO J2 \REM CONVERT LINE TO A STRING
4110 X$=X$+CHR$(A(I))
4115 NEXT I
4120 C=0
4125 FOR I=1 TO LEN(X$) \REM CHECK FOR PROPER NO. OF '\'
4130 IF X$(I,I)="\" THEN C=C+1
4135 NEXT I
4140 IF C<2 THEN 4340 \REM LINE IN ERROR
4145 IF C=2 THEN 4160
4150 IF C>3 THEN 4340
4155 IF X$(LEN(X$))<>"\" THEN 4340
4160 E1$=""
4165 FOR I=1 TO LEN(X$)
4170 IF X$(I,I)="\" THEN EXIT 4185
4175 E1$=E1$+X$(I,I)
4180 NEXT I
4185 IF E1$="" THEN CO=1 ELSE CO=0 \REM CO = NO. OF BLANK FIELDS
4190 FOR K=1 TO K1-LEN(E1$)
4195 E1$=E1$+" "
4200 NEXT K
```

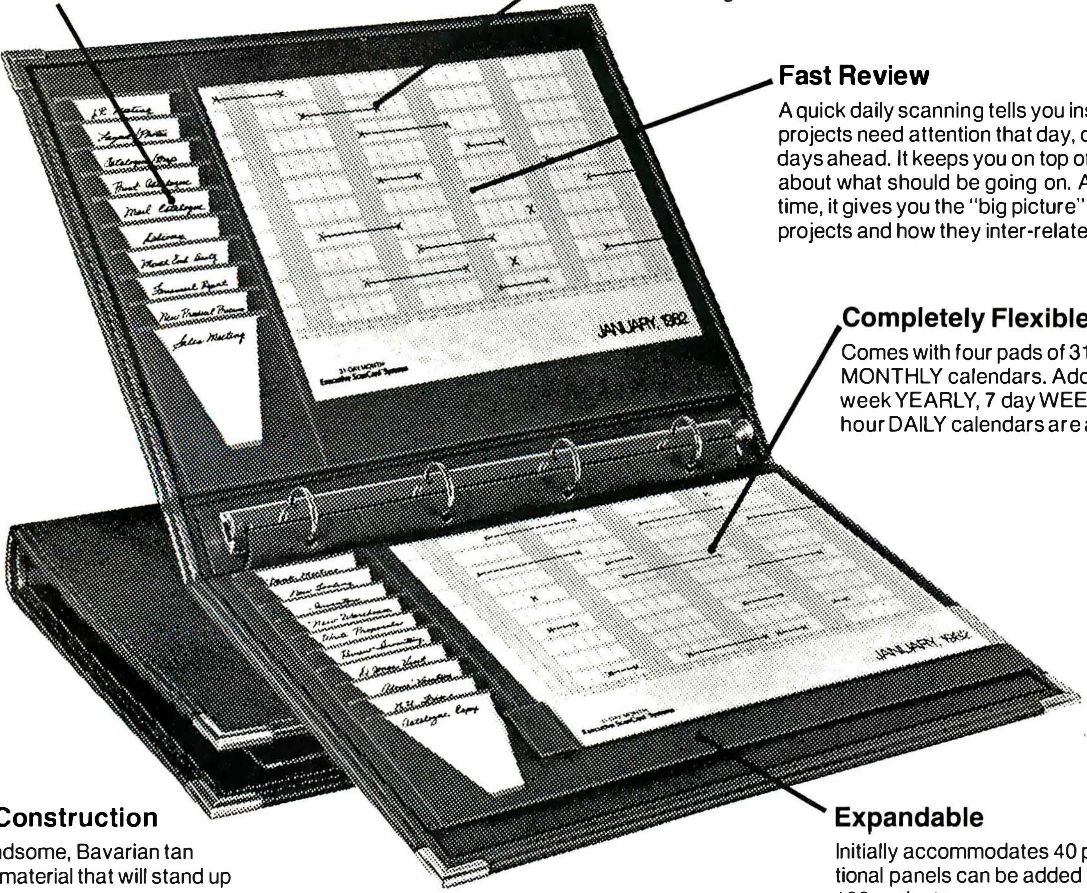
Listing 8 continued on page 372

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```
4205 E2$=""
4210 FOR J=I+1 TO LEN(X$)
4215 IF X$(J,J)="\" THEN EXIT 4230
4220 E2$=E2$+X$(J,J)
4225 NEXT J
4230 IF E2$="" THEN C0=C0+1 \REM INCREMENT BLANK FIELD COUNTER
4235 FOR K=1 TO K2-LEN(E2$)
4240 E2$=E2$+" "
4245 NEXT K
4250 E3$=""
4255 FOR I=J+1 TO LEN(X$)
4260 IF X$(I,I)="\" THEN EXIT 4275
4265 E3$=E3$+X$(I,I)
4270 NEXT I
4275 IF E3$="" THEN C0=C0+1 \REM INCREMENT BLANK FIELD COUNTER
4280 FOR K=1 TO K3-LEN(E3$)
4285 E3$=E3$+" "
4290 NEXT K
4295 IF S=0 THEN 4310
4300 GOSUB 4365 \REM DELETE ENTRY
4305 GOTO 4025
4310 IF C0<>3 THEN 4325 \REM CHECK FOR ALL FIELDS BLANK
4315 GOSUB 4465 \REM ERROR IN ENTRY
4320 GOTO 4025
4325 E$=E$+E1$+E2$+E3$
4330 E=E+1
4335 GOTO 4025
4340 GOSUB 8000 \REM CHECK FOR PAGE HEADING
4345 PRINT #D2,"COULDN'T PROCESS LINE",%6I,A(2)+A(3)*256," IN UPDATE FILE."
4350 GOTO 4025
4355 CLOSE #D5
4360 RETURN
4365 REM* ROUTINE TO DELETE AN ENTRY
4370 X$="" \FOR I=1 TO K9 \X$=X$+" " \NEXT I
4375 S1=0 \REM INDICATOR FOR ENTRY FOUND
4380 REM DETERMINE WHICH FIELDS ARE BLANK
4385 IF E1$=X$(1,K1) THEN I1=0 ELSE I1=1
4390 IF E2$=X$(1,K2) THEN I2=0 ELSE I2=1
4395 IF E3$=X$(1,K3) THEN I3=0 ELSE I3=1
4400 FOR I=1 TO E
4405 IF I1 THEN IF E1$<>E$(K9*I-K9+1,K9*I-K2-K3) THEN 4425
4410 IF I2 THEN IF E2$<>E$(K9*I-K2-K3+1,K9*I-K3) THEN 4425
4415 IF I3 THEN IF E3$=E$(K9*I-K3+1,K9*I) THEN EXIT 4490
4420 IF NOT I3 THEN EXIT 4490
4425 NEXT I
4430 REM ENTRY NOT FOUND
4435 IF S1=1 THEN RETURN  \REM ENTRY HAS BEEN FOUND - NO MSG
4440 GOSUB 8000 \REM CHECK FOR PAGE HEADING
4445 PRINT #D2,"COULDN'T FIND ENTRY TO DELETE THAT IS ON LINE ",
4450 PRINT #D2,A(2)+A(3)*256,"."
4455 RETURN
4460 REM INVALID DELETE REQUEST
4465 GOSUB 8000 \REM CHECK FOR PAGE HEADING
```

Listing 8 continued on page 374

Listing 8 continued:

```
4470 PRINT #D2,"AT LEAST ONE FIELD MUST BE NON-BLANK ON LINE ",
4475 PRINT #D2,A(2)+A(3)*256,"."
4480 RETURN
4485 REM FOUND ENTRY TO DELETE
4490 FOR J=I TO E-1
4495 E$(K9*J-K9+1,K9*J)=E$(K9*J+1,K9*J+K9)
4500 NEXT J
4505 E$=E$(1,LEN(E$)-K9) \REM TRUNCATE STRING BY ONE ENTRY
4510 E=E-1 \REM DECREMENT ENTRY COUNTER
4515 S1=1 \REM SET INDICATOR TO ENTRY FOUND
4520 GOTO 4400 \REM LOOK FOR ANOTHER TO DELETE
5000 REM*-------------------
5010 REM* SUBROUTINE TO SORT THE MERGED DATA
5020 REM*-------------------
5030 DEF FNF$(X)
5040 ON M GOTO 5050, 5060, 5070
5050 RETURN E$(K9*X-K9+1,K9*X-K2-K3)
5060 RETURN E$(K9*X-K2-K3+1,K9*X-K3)
5070 RETURN E$(K9*X-K3+1,K9*X)
5080 FNEND
5090 DEF FNP(X)=(X-((X/2-INT(X/2))*2))/2
5100 DEF FNB(X)
5110 K=0
5120 IF FNF$(X+X)<FNF$(X+X+1) THEN K=1
5130 RETURN X+X+(K AND (X+X<T))
5140 FNEND
5150 FOR T=2 TO E
5160 Q$=FNF$(T) \Q0$=E$(K9*T-K9+1,K9*T) \I=T
5170 IF I=1 THEN 5220
5180 J=FNP(I)
5190 IF Q$<=FNF$(J) THEN 5220
5200 E$(K9*I-K9+1,K9*I)=E$(K9*J-K9+1,K9*J) \I=J
5210 GOTO 5170
5220 E$(K9*I-K9+1,K9*I)=Q0$
5230 NEXT T
5240 T=E
5250 B$=FNF$(T) \B0$=E$(K9*T-K9+1,K9*T)
5260 E$(K9*T-K9+1,K9*T)=E$(1,K9) \T=T-1 \I=1
5270 IF I+I>T THEN 5320
5280 J=FNB(I)
5290 IF FNF$(J)<=B$ THEN 5320
5300 E$(K9*I-K9+1,K9*I)=E$(K9*J-K9+1,K9*J) \I=J
5310 GOTO 5270
5320 E$(K9*I-K9+1,K9*I)=B0$
5330 IF T>=2 THEN 5250
5340 RETURN
6000 REM*-------------------
6010 REM* SUBROUTINE TO WRITE OUT NEW MASTER
6020 REM*-------------------
6030 F$=F1$+U1$ \L9=INT((LEN(E$)+3*L2*E+255)/256)
6040 IF FILE(F$)=-1 THEN 6060
6050 DESTROY F$
6060 CREATE F$,L9
6070 OPEN #D4,F$
```

Listing 8 continued on page 376

Circle 437 on inquiry card.

Listing 8 continued:

```
6080 FOR I=1 TO E
6090 WRITE #D4,E$(K9*I-K9+1,K9*I-K2-K3)
6100 WRITE #D4,E$(K9*I-K2-K3+1,K9*I-K3)
6110 WRITE #D4,E$(K9*I-K3+1,K9*I)
6120 NEXT I
6130 CLOSE #D4
6140 RETURN
7000 REM*--------------------
7010 REM* RETURN TO SUBEXECUTIVE
7020 REM*--------------------
7030 IF P=0 THEN 7070
7040 FOR I=P5-L-2 TO P5 \REM EJECT TO A NEW PAGE
7050 PRINT #D2
7060 NEXT I
7070 CHAIN S$+","+U$
8000 REM*--------------------
8010 REM* SUBROUTINE FOR PAGE HEADING
8020 REM*--------------------
8030 IF L=0 THEN 8060
8040 L=L-1
8050 RETURN
8060 IF P=0 THEN 8100
8070 FOR I=1 TO P7 \REM BOTTOM MARGIN
8080 PRINT #D2
8090 NEXT I
8100 P=P+1
8110 FOR I=1 TO P6 \REM TOP MARGIN
8120 PRINT #D2
8130 NEXT I
8140 PRINT #D2,"ERRORS",TAB(40-INT((LEN(D$)+LEN(T$)+2)/2)),
8150 PRINT #D2,D$,"  ",T$,TAB(73),"PAGE",%3I,P
8160 PRINT #D2
8170 L=P5-P6-P7-3
8180 RETURN
```



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Circle 310 on inquiry card.

Listing 9: *The list program (%!LIST). The subroutines at lines 1000, 2000, and 5000 isolate interaction with the subexecutive program and the job-control file.*

```
10 REM* SAMPLE LIST PROGRAM (SAVED IN FILE '%!LIST')
20 REM* 11/18/80 WRITTEN BY GENE F. WALTERS
30 GOSUB 1000 \REM READ IN GLOBAL DATA
40 GOSUB 2000 \REM READ IN LIST COMMAND DATA & INITIALIZATION
50 GOSUB 3000 \REM READ AN ENTRY FOR PRINTING
60 IF Z THEN 90 \REM TEST FOR END OF FILE
70 GOSUB 4000 \REM PRINT ENTRY
80 GOTO 50
90 GOSUB 5000 \REM PROGRAM WRAPUP & RETURN TO SUBEXECUTIVE
1000 REM*------------------
1010 REM* SUBROUTINE TO READ IN GLOBAL DATA
1020 REM*------------------
1030 DIM P$(80),L(3)
1040 D1=0 \REM DEVICE FOR CONSOLE
1050 D2=1 \REM DEVICE FOR PRINTER
1060 D3=0 \REM DISK FILE FOR THE SYSTEM
1070 D4=1 \REM MASTER FILE
1080 U=3 \REM NO. OF DRIVES IN SYSTEM
1090 S$="%!" \REM PREFIX FOR SYSTEM FILE NAMES
1100 FOR I=1 TO U
1110 U$=CHR$(I+48)
1120 IF FILE(S$+"JCL,"+U$)=3 THEN 1150
1130 NEXT I
```

Listing 9 continued on page 380

Text continued from page 366:

global data stored at the beginning of the job-control file.

2000–2130 Read in Parameters for Program Execution. Using the current-entry pointer near the beginning of the job-control file, lines 2040 through 2070 position to the entry containing the parameters for the update/sort program's execution. Lines 2090 through 2110 then read in those parameters.

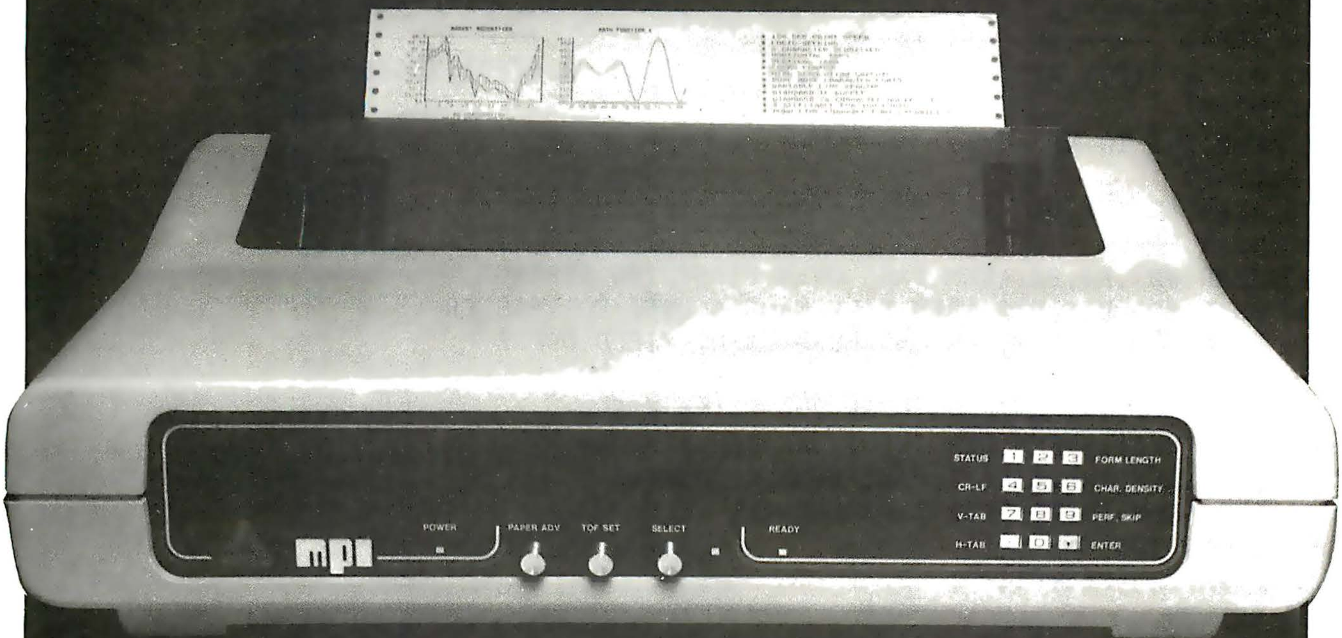
7000–7070 Return to Subexecutive. This section of code first positions the paper when an error listing is produced. The code uses the current line number, L, and the number of lines per page, P5, to calculate the number of blank lines to print in order to eject the listing to a new page. As a result, the printer should start at the top of a new page after each program's execution. Line 7070 CHAINs to the subexecutive.

The List Program

Listing 9 is the list program (%!LIST). Again, I will describe only those features of the list program that

Text continued on page 382

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Circle 293 on inquiry card.

Listing 9 continued:

```
1140 PRINT #D1,"COULDN'T FIND JOB CONTROL FILE." \END
1150 OPEN #D3,S$+"JCL,"+U$
1160 READ #D3,N,N0,N1 \REM-# CMD ENTRIES, CURRENT CMD, PTR TO 1ST ENTRY
1170 READ #D3,P$ \REM PASS OVER FIRST STRING
1180 READ #D3,D$,T$ \REM READ IN DATE AND TIME
1190 READ #D3,P5,P6,P7 \REM LINES/PAGE, TOP MARGIN, BOTTOM MARGIN
1200 READ #D3,L(1),L(2),L(3) \REM MAX LENGTH FOR TITLE, AUTHOR, DATE
1210 RETURN
2000 REM*-------------------
2010 REM* SUBROUTINE TO READ IN LIST COMMAND DATA & INITIALIZATION
2020 REM*-------------------
2030 DIM P1$(80),P2$(80),P3$(80),P(3),X1$(80),X2$(80),X3$(80)
2040 P2=N1
2050 FOR I=1 TO N0
2060 P1=P2
2070 READ #D3%P1,P2
2080 NEXT I
2090 READ #D3,P$,P$ \REM PASS OVER FIRST TWO STRINGS
2100 READ #D3,F1$,U1$ \REM FILE NAME & UNIT FOR MASTER
2110 READ #D3,P(1),P(2),P(3) \REM PRINT FIELD ORDER
2120 L1=L(P(1)) \REM LENGTH OF 1ST PRINT FIELD
2130 L2=L(P(2)) \REM LENGTH OF 2ND PRINT FIELD
2140 L3=L(P(3)) \REM LENGTH OF 3RD PRINT FIELD
2150 P=0 \REM INITIALIZE PAGE NUMBER COUNTER
2160 L=0 \REM INITIALIZE LINE COUNTER
2170 CLOSE #D3
2180 OPEN #D4,F1$+U1$
2190 RETURN
3000 REM*-------------------
3010 REM* SUBROUTINE TO READ AN ENTRY
3020 REM*-------------------
3030 Z=0
3040 IF TYP(D4)<>0 THEN 3060
3050 Z=1 \RETURN  \REM END OF FILE
3060 READ #D4,X1$,X2$,X3$
3070 ON P(1) GOTO 3080, 3090, 3100
3080 P1$=X1$ \GOTO 3110
3090 P1$=X2$ \GOTO 3110
3100 P1$=X3$
3110 IF LEN(P1$)>L1 THEN P1$=P1$(1,L1) \REM TRUNCATE IF TOO LONG
3120 ON P(2) GOTO 3130, 3140, 3150
3130 P2$=X1$ \GOTO 3160
3140 P2$=X2$ \GOTO 3160
3150 P2$=X3$
3160 IF LEN(P2$)>L2 THEN P2$=P2$(1,L2) \REM TRUNCATE IF TOO LONG
3170 ON P(3) GOTO 3180, 3190, 3200
3180 P3$=X1$ \GOTO 3210
3190 P3$=X2$ \GOTO 3210
3200 P3$=X3$
3210 IF LEN(P3$)>L3 THEN P3$=P3$(1,L3) \REM TRUNCATE IF TOO LONG
3220 RETURN
4000 REM*-------------------
4010 REM* SUBROUTINE TO PRINT AN ENTRY
4020 REM*-------------------
```

Listing 9 continued on page 382

Listing 9 continued:

```
4030 GOSUB 4060 \REM PRINT HEADING IF REQUIRED
4040 PRINT #D2,P1$,TAB(L1+1),P2$,TAB(L1+L2+2),P3$
4050 RETURN
4060 REM*-------------------
4070 REM* SUBROUTINE TO PRINT HEADING
4080 REM*-------------------
4090 IF L=0 THEN 4120
4100 L=L-1
4110 RETURN
4120 IF P=0 THEN 4160
4130 FOR I=1 TO P7 \REM BOTTOM MARGIN
4140 PRINT #D2
4150 NEXT I
4160 P=P+1
4170 FOR I=1 TO P6 \REM TOP MARGIN
4180 PRINT #D2
4190 NEXT I
4200 PRINT #D2,"ARTICLE/BOOK LIST",TAB(40-INT((LEN(D$)+LEN(T$)+2)/2)),
4210 PRINT #D2,D$,"  ",T$,TAB(73),"PAGE",%3I,P
4220 PRINT #D2
4230 ON P(1) GOTO 4240, 4250, 4260
4240 PRINT #D2,"TITLE",TAB(L1+1), \GOTO 4270
4250 PRINT #D2,"AUTHOR",TAB(L1+1), \GOTO 4270
4260 PRINT #D2,"DATE",TAB(L1+1),
4270 ON P(2) GOTO 4280, 4290, 4300
4280 PRINT #D2,"TITLE",TAB(L1+L2+2), \GOTO 4310
4290 PRINT #D2,"AUTHOR",TAB(L1+L2+2), \GOTO 4310
4300 PRINT #D2,"DATE",TAB(L1+L2+2),
4310 ON P(3) GOTO 4320, 4330, 4340
4320 PRINT #D2,"TITLE" \GOTO 4350
4330 PRINT #D2,"AUTHOR" \GOTO 4350
4340 PRINT #D2,"DATE"
4350 PRINT #D2
4360 L=P5-P6-P7-5
4370 RETURN
5000 REM*-------------------
5010 REM* RETURN TO SUBEXECUTIVE
5020 REM*-------------------
5030 FOR I=P5-L-2 TO P5 \REM EJECT TO A NEW PAGE
5040 PRINT #D2
5050 NEXT I
5060 CLOSE #D4
5070 CHAIN S$+","+U$
```

Text continued from page 378:

relate to its overall structure and its use of the executive.

30–90 Overall Program Flow. I again used the approach of controlling program flow by using a series of GOSUB statements. The subroutines at lines 1000, 2000, and 5000 isolate interaction with the subexecutive and the job-control file.

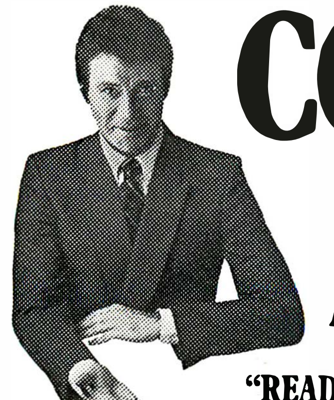
1000–1210 Read in Global Data. These lines are similar to lines 1000 through 1270 in the update/sort program but do less processing after reading the parameters.

2000–2190 Read in Parameters for Program Execution. These lines read in parameters for executing the rest of this program.

5000–5070 Return to Subexecutive. After positioning the printer to a new page, this section transfers control back to the subexecutive.

Adapting for your Application

You can adapt these programs for your application in two ways. One is to retain the same basic functions in the system but change the fields to be



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Separate Numeric Key Pad	Standard	Standard	NO	Standard
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These systems were configured to approximate the capabilities of the 16K PET® 4016. Disk drives and printers are not included in prices. Models shown vary in their degree of expandability.

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1 VisiCalc is a Trademark of Personal Softwear, Inc.
2 The Portfolio Management System was created by Micro Business Systems, Inc.
3 OZZ was created by the Bristol Software Factory.
4 MAS and LTA were created by Cimarron Corp.



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maintained; the other is to use the structure and the supporting utility routines for an entirely different set of tasks.

As an example of the easier case, let's assume you want to maintain a directory of all your program and data files where each entry contains the following fields: disk identification, file name, type of file, date of last update, and description of file contents. This system has five fields rather than the three in the Article/Book Maintenance System. The lines of the programs to change are shown in table 1. As this example shows, you can retain much of the original system for the new application. But this system has a major limitation on the number of entries that can be maintained, because the entire file must be in memory for the sort process. Additional code could be written in the update/sort program to perform the sorting process on disk to remove this limitation.

Now let's look at how to adapt the batch-processing system for an application quite different from the original Article/Book Maintenance System. The MAIN program is made to be flexible. You can adapt it to meet the requirements of the programs that are to be incorporated; just set up the appropriate global parameters and parameters specific to the programs you want to use. This is done by deleting lines 3000 through 5230 from the MAIN program (see listing 6). Also change lines 100 and 360 to reflect the commands that you need. Determine all the parameters that will be used by two or more programs to be run in a batch. Then,

MAIN Program (Save in a file with a name of your choice)

Lines	Modification
3380-3460	Change for your options
4130-4580	Change for your options
5160-5210	Change for proper length of each field
64520	Change the name to one of your choice

Subexecutive (%!)

No change required

Update/Sort Program (%!SORT)

Lines	Modification
1210-1240	Change for the different fields
3080-3090	Change for the different fields
4290	Provide more code for the two additional fields
4310	Change 3 to 5 for the proper number of fields
4325	Change for the additional two fields
4395-4560	Change and provide more code for the two additional fields
5040-5070	Change and provide more code for the two additional fields
6090-6110	Change and provide more code for the two additional fields

List Program (%!LIST)

Lines	Modification
1030	Change for additional fields
1200	Change for additional fields
2030	Change for appropriate length of print line
2110	Change for additional fields
2140	Provide more code for additional fields
3060-3210	Change and provide more code for the two additional fields
4040	Change for the additional fields
4200	Change for the appropriate heading and print line length
4230-4340	Change subheading

Table 1: *Changes required to adapt the Article/Book Maintenance System for maintaining disk directories. This table shows the required changes in each of the batch-processing system's four programs, with line-number references in each.*

using the utility routines found in lines 64000 through 65080, write a routine to set up the global parameters in the job-control file. This approach assures that if you want to change a parameter later, you will need to make only a simple modification in the MAIN program.

Next, again using the utility routines, write a routine for each command required. Remember the importance of checking that all parameters to be written to the job-control file are reasonable. The Article/Book Maintenance System handles only string input. If you want to accept a numeric value, first read it in as a string, then call the routine at line 64990 to check for null input, and then convert the string to a numeric value by using the BASIC function VAL.

Finally, use the basic structure of the programs listed here as the model for the programs to be run under your batch-processing system.

Conclusion

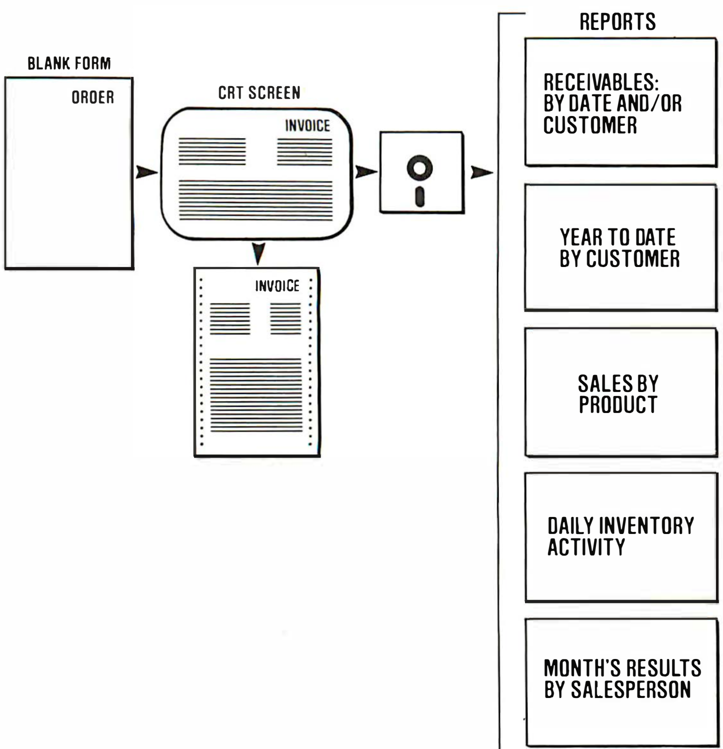
It is irritating to have to attend a computer and nurse it through a series of repetitive operations. After all, the computer is supposed to be a laborsaving and timesaving device, especially useful for repetitious tasks that people hate. But what will save you from the labor and time required to supervise and redirect the computer through a series of repetitions?

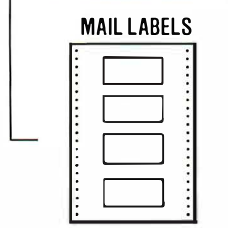
The answer is batch-processing software. Once you have a batch-processing system working, you'll find that you can easily adapt it for various specific applications. While the computer works on one set of tasks, you will be free to concentrate on another, or simply relax. I hope that the batch-processing system that I have described proves as helpful to you as it has to me. ■

The author will send interested BYTE readers a 5¼-inch, single-density North Star disk containing the programs described in this article. The programs on the disk, which costs $15, include both the Article/Book Maintenance System programs and the set of programs for maintaining disk directories.

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BYTELINES

News and Speculation about Personal Computing

Conducted by Sol Libes

Random Rumors: IBM is expected to expand distribution of its Personal Computer in the second half of this year; look for distribution through channels other than Computerland and Sears. Reportedly, IBM is taking a look at mail-order and nonfranchised computer stores. It's also rumored that IBM is readying a smaller computer system designed specifically for mail-order sales and that the Pick operating system for the Personal Computer will be released soon. There's word of a deal between IBM and Motorola for the development of a 370/4300-computer-compatible system of software to run on Motorola's 68000. . . . Epson America is rumored to be developing a desktop personal computer for the low-end business market. . . . Software Arts, Cambridge, Massachusetts (the outfit that developed Visicalc) is said to be developing another revolutionary program for a leading hardware manufacturer. . . . Commodore is expected to finally release its 16-bit microprocessor that will be software compatible with the 6502.

NCC Predictions: Here are some of the new items that I expect to see introduced at the NCC show next month in Houston: look for Apple Computer Inc. to finally introduce the Apple IV using a 68000 microprocessor, a Unix-like operating system, sophisticated graphics, and networking functions. . . . Expect DEC (Digital Equipment Corporation) to finally introduce its personal computer system based on the venerable PDP-8. . . . Look for Zenith to introduce its Z-100 16-bit computer system, rumored to use the Microsoft MS-DOS (the operating system used on the IBM Personal Computer). . . . Commodore will formally introduce its new personal computer that can emulate the Apple, Radio Shack, and IBM systems and run CP/M. . . . I expect Xerox to introduce a portable version of its Xerox 820 computer/word-processor system. . . . Expect a 3.25-inch 3.3-megabyte "baby Winchester" disk drive from a U.S. vendor (check out the Sony, Monroe, Osborne, and Otrona booths for prototypes) and 5¼-inch hard-disk drives with 30-megabyte capacity from Tandon and Control Data. . . . Epson is rumored to be readying a 1-megabyte, very thin 5¼-inch floppy-disk drive for showing at NCC. . . . Also, Integral Data Systems is expected to debut a dot-matrix printer with an 18-wire head to provide high-quality print.

Growing 68000 Market: As predicted several months ago in this column, Radio Shack has released its TRS-80 Model 16 using a 68000 16-bit microprocessor. Following in the footsteps of companies such as Godbout and Cromemco, the Model 16 is a dual-processor system that uses both an 8-bit Z80 processor and a 16-bit 68000 processor. This "hardware now, software later" strategy will allow purchasers to run Z80 software until 68000 software becomes available. Tandy expects to release a three-user (reportedly Unix-like) operating system over the summer and may have several languages available later. Applications software should be available starting in 1983.

Although the Radio Shack TRS-80 Model II has proved to be a very good single-user business system, the Model 16 represents a significant step upward for Tandy in its attempts to compete with IBM, DEC, et al., in the very lucrative multiuser business market. The Model 16 also offers options of an Arcnet local network interface, memory expansion up to 512K bytes and hard-disk storage.

Rather than design a completely new computer from the ground up, as Apple is doing, Tandy has developed its Model 16 by adding the 68000 system to its Model II, replacing the single 8-inch floppy-disk drive with two slim-line drives (1.25 megabytes per drive), and changing the color of the cabinet from battleship gray to ivory-white. The basic unit with 128K bytes of memory and 1.25 megabytes of disk storage lists for $5000; however, if you want additional memory, a second floppy-disk drive, and a hard disk, you can expect a price of over $10,000 (some Radio Shack dealers are already offering 15 percent discounts). Tandy also offers to upgrade Model II machines to most of the features of the Model 16 for $1500—it's nice to see a company that doesn't forget its old customers.

Considering that Radio Shack's line of computers now ranges from tiny pocket computers to 16-bit multiuser systems, the next question is Will Radio Shack's next machine be a true 32-bit microcomputer?

Apple and PET users who want to upgrade to 16-bit processors need not feel left out in the cold. Several independent vendors are already offering plug-in and add-on 68000 and 8088 processor cards. For example, Digital Acoustics, Santa Clara, California, offers a 68000 processor card that can be attached to an Apple or PET for $700 to $1400, depending on the amount of additional memory (actually, the unit can be interfaced to any system via I/O ports and appropriate software). Metamorphic Microsystems, Boulder, Colorado, offers a card for the Apple that incorporates an Intel 8088, and also has available CP/M-86, MP/M-86, and UCSD Pascal 4.0. A 68000 Apple plug-in card is already being sold in England. (As yet, no software is available for the 68000 product.)

For almost a year now S-100 system owners have had 68000 processors available to them, with a variety of different multiuser Unix-like operating systems and development languages, from suppliers such as Empirical Research Group, Milton, Washington; MicroDaSys, Santa Monica, California; Dual Systems Control, Berkeley, California; and Cromemco, Mountain View, California. Already available

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for these systems are languages such as Pascal, FORTH, FORTRAN, and BASIC. Prices for these systems are equal to or less than the Radio Shack prices.

Several other 68000-system suppliers are already delivering 68000 systems at under $5000. Most notable are the Fortune 32:16 (already in Computerland stores) and the Sage II from Sage Computer Technology, Reno, Nevada, starting at $3600.

Apple Computer's 68000 machine, which will not become available until the second half of the year at the earliest, will encounter a highly competitive 68000 marketplace. It will have to be darned good to compete.

IBM Doings: Like every other personal computer manufacturer, IBM underestimated the market for its product. It initially expected to sell about 100,000 units this year, but the company has greatly expanded its manufacturing facilities and now is expecting to ship 200,000 Personal Computers, thus generating between $500 and $600 million in revenue (which should still be a small fraction of IBM's total yearly $30 billion revenue). This should make IBM number three in the personal computer marketplace, following Apple Computer Inc. and Radio Shack (both companies are expected to ship over 300,000 systems this year). In fact, just about every personal computer manufacturer expects to set records this year. In the meantime, many IBM customers must wait as long as two months for delivery.

Sales of the IBM Personal Computer are currently limited to the U.S., although some dealers are reshipping to dealers outside the U.S. However, IBM is expected to start shipping to foreign dealers before the year is out.

Although users are generally pleased with the Personal Computer, there are some complaints: users say IBM has not made it easy to expand its system with additional memory and accessory devices, that the keyboard differs from IBM's conventional keyboards, that the system takes up more desk space than competing systems, that competitors can match or even exceed the IBM's performance in many areas, and—the biggest complaint—that the few programs available are too complex. Also, IBM hampered independent suppliers of add-on peripherals by not releasing technical information until several months after the unit was released.

There are rumors that IBM will introduce a new, lower-cost personal computer later this year or in early 1983. Also of interest is the fact that Telesoft, San Diego, California, recently demonstrated its new Ada compiler on an IBM Personal Computer enhanced with 256K bytes of memory and a 6-megabyte hard-disk drive.

Justice Department vs AT&T and IBM: The Justice Department, after many years of pursuit and incalculable expense, has finally settled its antitrust suit with AT&T and dropped its suit against IBM. This means that AT&T is now free to become a formidable competitor in

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SSM AIO Serial/Para. Interface	$ 159	20%
★ ALS: Smarterm 80 Col Card	$ 269	30%
Z-Card (Z-80)	$ 209	22%
Addram 16K Card	$ 119	20%
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Apple Pie (specify brd.)	$ 99	25%
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Howard Software		
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the nonregulated computer/communications marketplace. To grasp the potential impact of this decision, consider that last year AT&T's Bell Laboratories spent $1.6 billion on research and development—more than the total amount spent by Japan's Ministry of International Trade and Industry.

Last year alone Western Electric, AT&T's manufacturing arm, produced more 64K-bit dynamic-memory integrated circuits than any other U.S. supplier and is already producing the MAC-32 32-bit microprocessor. Bell Labs has already disclosed the design of a 256K-bit dynamic-memory chip. Consider also the attention the industry is focusing on Unix. AT&T's Advanced Communications Service, scheduled to go online shortly, promises to tie together computers, networks, and communications terminals in an incredibly advanced and massive computer operation.

IBM is free to pursue the same path. The company has already reentered the time-sharing business and is spending about 10 percent of its revenues (almost $2 billion) on research.

Apple Doings: After failing in the courts to cancel Apple Computer Inc.'s ban on mail-order sales, one of the six mail-order dealers cut off by Apple has filed a formal complaint with the Federal Trade Commission, charging Apple with price fixing and violation of the Sherman Antitrust Act. In the meantime, mail-order sales continue from nonauthorized Apple dealers who buy their units from authorized Apple dealers and still manage to offer discounts.

Apple finally appears to have gotten the Apple III off the ground by cutting the price by $400, increasing the dealer margin to 33.4 percent, offering a new, sophisticated operating system and seven application software packages (including CP/M), and making significant hardware improvements and options (including a built-in 5-megabyte hard disk). Reportedly, only 10,000 of the original Apple IIIs were sold compared to more than 350,000 Apple IIs sold through the end of 1981.

Word has it that Apple has spent $30 million in the development of its two new microcomputer systems, which it hopes to formally announce at NCC. Apple has kept tight wraps on information about these two units; however, rumors abound that one, called "Lisa," is intended for the business market and will be a workstation system using a 68000 processor. It should have a Unix-like operating system, hard disk, 128K bytes of memory, Ethernet interface, and a base price of at least $5000. The second system is rumored to be a low-cost portable system that will be software-compatible with the Apple II. It has been designated the "Super II." One question is What will happen to the Apple II and III when these new units are released?

Slim-line Floppy Race Heats Up: The slim-line 8-inch floppy-disk drives are

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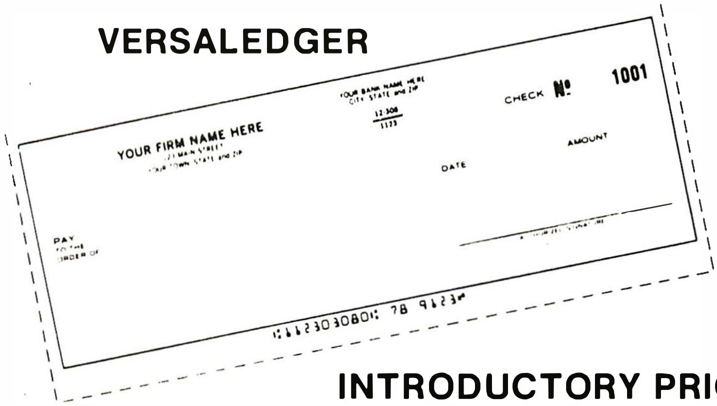
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the first major redesign of this hardware to have occurred in several years. These drives are typically half the height of a standard drive. This makes it possible to double storage capacity without changing the cabinet, because you can stack two slim-line drives in the space previously occupied by one standard drive. Furthermore, manufacturers have reduced the length of the new 8-inch drives by at least two inches.

The genesis of the slim-line design is credited to Micro Peripherals, Chatsworth, California, which introduced the first slim-line drive in the spring of 1980 but did not start shipping until November of that year. Tandon, also in Chatsworth, introduced a slim-line drive at last year's NCC show and has since introduced a double-sided version. Tandon is currently the only high-volume supplier of these drives. Shugart Associates has introduced an 8-inch slim-line drive, and Siemens is expected to show prototypes of its drive at NCC next month. At least six Japanese suppliers are expected to show 8-inch slim-line drives at NCC, many of which are already being delivered in Japan.

Although prices for the slim-line drives are currently higher than standard drives, these prices are expected to fall quickly as manufacturers gear up to full production. In the long run, prices are expected to be significantly lower than standard drives because manufacturers are further along the learning curve in design and manufacturing techniques.

Last year saw a turning point in the floppy-disk market as shipments of 5¼-inch drives overtook shipments of 8-inch drives. Although the new slim-line 8-inch drives are expected to bolster sales of 8-inch drives in general, they are not expected to significantly affect 5¼-inch shipments. Estimates for 1982 are that 1.9 million 8-inch and 3 million 5¼-inch drives will be shipped.

Incidentally, a reported 250 million disks were sold through the end of 1981; 125 million were sold in 1981 alone.

Microcomputer Profits: Apple Computer reported that its net income for the first quarter of 1981 rose 83 percent to $13.6 million on revenues of $133.6 million. But that's nothing compared to Atari! Warner Communications, which owns Atari, reported that Atari sales last year doubled to $1.2 billion, while income quadrupled to $287 million. Incidentally, when Warner bought Atari in 1976, sales were about $40 million—Warner is reaping a video game bonanza. Corvus Systems reported that its sales for 1981 more than quadrupled over the previous year, from $2.7 million to $11.4 million. Corvus is now two and a half years old.

Exxon Corp., which for the last few years has attempted to establish itself in the microcomputer field (with Zilog, Vydec, et al.) reported that its Office Systems subsidiary lost $76 million in 1981—oh well, I guess Exxon needed a big tax loss.

Dvorak Keyboard on Personal Computers: The Dvorak typewriter keyboard configuration has long been recognized as considerably more efficient than the conventional QWERTY keyboard configuration. Unfortunately, the conventional configuration has been with us for many years and changing it is assumed to be difficult and expensive; however, owners of personal computers whose keyboards are software controlled can make the change easily by changing the software which scans the keys, and recent studies show that increased production more than balances the slight effort required. Software is already available for the TRS-80 Models I and III, Apple II, and Exidy Sorcerer microcomputers. People who are interested in reconfiguring their personal computers to use the Dvorak keyboard configuration should contact Quick Strokes (the newsletter for Dvorak keyboard users), POB 643, West Sacramento, CA 95691.

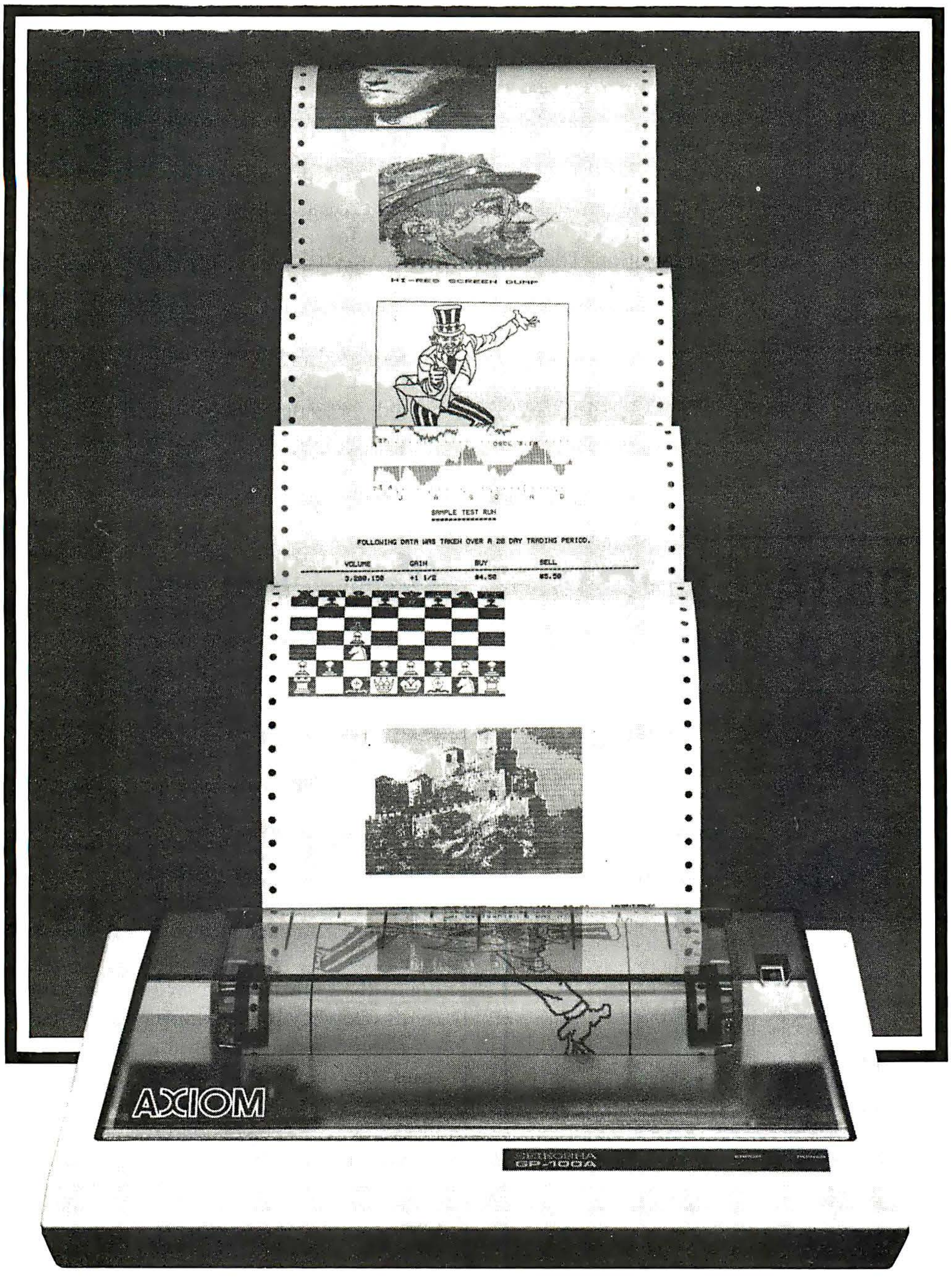
Videodiscs that can Record: Sharp Corp., Osaka, Japan, has disclosed that it has developed a videodisc system with recording capability. Based on a thermomagnetic effect, it employs a silicon laser and a 5¼-inch disk, similar to a floppy disk, that can store up to 200 megabytes. The unit is expected to be in production within two years.

Foreign Exchange: If you're into computer bulletin boards and are tired of accessing U.S. bulletin board systems, why not try a foreign BBS such as FORUM-80 London (01-286-6207), CBBS-London (01-286-6207), or FORUM-80 Holland (010-313-512-533).

Illegal Access: Before the FBI and the courts put him out of business, a California teenager developed a hobby of illegally accessing computer systems. He had ac-

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cessed computers belonging to U.S. Leasing, UCLA, UCA, DEC, and even law enforcement agencies. How did he do it? How did he get the access codes and passwords? Some he got by going through printouts he found in company trash cans, some by trial and error, and others by posing as a law officer or computer repairman. Why did he do it? "Just for kicks!"

Computers and the Handicapped: Microcomputers are being used in many ways to help the handicapped help themselves to become more effective in the job market, more independent as individuals, and able to coexist with nonhandicapped persons on a more equal basis. A new organization to help this effort is "Computers to Help People," Madison, Wisconsin, founded by John Boyer, a grad student in computer science who is both deaf and blind.

Intel Upgrades 8086: Intel has introduced a new microprocessor, called the 80286, that is software-compatible with the company's 8086 16-bit microprocessor. The new processor has an on-chip multilevel protection mechanism as well as capabilities for memory management and virtual-memory address translation. Thus, it's targeted for the multiuser and multitasking market. The integrated circuit has 68 pins.

Another upgrade that Intel is expected to release shortly is to be called the 80186. It will have on-chip clock and interrupt controllers, two DMA (direct memory access) channels, timers, counters, and random chip-select logic.

Unix Rumors: Tandy is expected to announce at NCC a Unix-like operating system for its new TRS-80 Model 16. Experts are betting that it will be Microsoft's Xenix. Rumors also suggest that Xenix will be implemented on the IBM Personal Computer and National Semiconductor's new 16-bit microcomputer . . . . Word has it that Unix IV with the Writer's Workbench is being readied for release to commercial customers early next year . . . Unix System V is reportedly being tested by AT&T and is expected to be adopted internally in about six months.

Random News Bits: Mattel Electronics has a new microcomputer game called Dallas. The processor, when playing the role of J.R., has been programmed to cheat, lie, and blackmail . . . Ithaca Intersystems' new version of Pascal/Z (version 4.0) has a unique feature: an interactive symbolic debugger called Swat. . . . If your rug is creating static problems with your computer, try spraying the rug with a mixture of two-thirds Downey Fabric Softener and one-third water in a spray bottle. . . . M/A-Com's purchase of Ohio Scientific Inc. seems to have determined Ohio Scientific's moving from the personal computer market to the business computer market—I note that the name of Ohio Scientific has been changed to "M/A-Com Office Systems Inc." . . . According to a report from Market Venture Consultants, Newport Beach, California, 20 percent of all personal computers sold today are used in business, and this should increase to over 30 percent by 1985. . . . Disk Trends, another marketing research organization, predicts that the 3½-inch floppy-disk drive is likely to become a major product, especially in office machines. It also predicts 3½-inch Winchester drives with 5-megabyte capacity in volume production by 1983. . . . Pertec Computer has given up manufacturing floppy-disk drives to concentrate on higher-margin tape and Winchester disk-drive products. . . . Lifeboat Associates has released CP/Emulator, a program that will allow software written with it to run under CP/M-86 and under Microsoft's MS-DOS (used on IBM's Personal Computer and others). Cost is $750. . . . Lifeboat Associates and Intel have cooperatively formed iRUG, a users group for Intel's iRMX-86 operating system. For information write iRUG, Lifeboat Associates, 1651 Third Ave., New York, NY 10028. . . . Intel is reportedly shipping its Ada compiler for the iAPX432 32-bit microprocessor and hopes to have its 432 development system available in the last quarter of this year.

Quote of the Month: "CP/M 2.2 is extremely important, and the Z80 chip will live forever because of it."
Dr. Portia Isaacson
Future Computing Inc.

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a self-addressed, stamped envelope.

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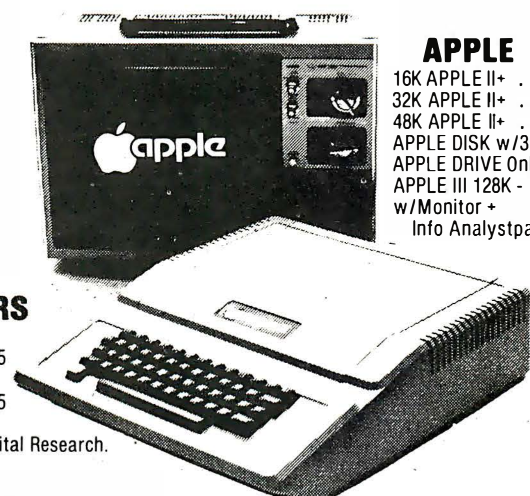
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Cows and Catalogs

Dear Steve,

Another gentleman and I are currently trying to adapt the Radio Shack TRS-80 Color Computer for farm-control applications. Initially, we plan to develop a system for computer-controlled feeding of dairy cows.

One of our biggest hurdles involves reliably identifying each cow (up to 250) as she approaches the feeder. We'd like the computer to decide how much feed she is to receive and to update each cow's statistics.

We need a unit that can be worn by the cow like a necklace and mated with control circuitry on the feeder. Obviously, durability and temperature sensitivity are major concerns. Do you have any ideas that might prove useful?

In a different vein, my library of device manufacturers' and distributors' catalogs is very small. Although it's not too difficult to get catalogs from distributors listed in magazines like BYTE, I know that there are many outfits that could prove more useful. I have the feeling that many distributors ignore the most versatile and useful components because of their limited appeal. Can you suggest a method of building a larger device and component library?

Gary L. Filkins Jr.
Otsego, MI

I am not familiar with cows, but I assume that you are not looking for a totally automated feeding arrangement and that someone will be available at the feeder to do whatever is necessary.

For reliability, I would suggest that the device around the cow's neck be a passive one, i.e., no batteries to replace. The first thing that comes to mind is a dog tag (cow tag?) with a bar code (similar to the Universal Product Code) printed on it. When a cow approaches the feeder, the tag is read with a light-sensitive wand and the computer prints out the feed requirements and other pertinent data. This would require an optical bar-code interface to your computer.

Another device would need a resistive element molded into the cow tag with two ends brought out to a connector or wiper. As a cow approached, she would "punch in" to a device that would incorporate the resistance in an oscillator circuit and output a frequency unique to each cow. The computer would identify each cow by the generated frequency. A unit must be constructed to use this concept.

Here are a couple of approaches to beef up your device manufacturers' and distributors' catalog library. First, the major semiconductor manufacturers publish data catalogs and application notes about their products. You can contact their literature departments directly. Second, you might like to get the Electronics Engineers Master Catalog, *which covers many manufacturers. It's available from United Technical Publications, Circulation Department, 645 Stewart Ave., Garden City, NY 11530. . . .* **Steve**

TV Jitter Bugs

Dear Steve,

When I use my TRS-80 Color Computer with an old Motorola tube-type color TV set, the picture is great. When I use it with my new 12-inch Sanyo, lots of evenly spaced horizontal bars fade in and out at about 1 Hz. Sometimes they disappear, at other times they appear diagonally or vertically. The controls have no effect, and similar bars appear much more dimly on a set in the Radio Shack store. On a 12-inch black-and-white portable TV, the bars are worse still and, in addition, the picture will sometimes bend as a "bump" rises slowly up the screen.

Is there something wrong with my set, or do all radio-frequency (RF) modulators do this? Can I just tap the signal going into the Astec RF modulator and pipe it directly into the video section of the set? I wrote Tandy Corporation and was referred to the manufacturer of my television. But why would it care whether my Color Computer works?

Charles Hall
Raleigh, NC

Your problem is not caused by the RF modulator, but by a slight "sync" incompatibility between the computer and the TV. Many of the newer TVs use phase-locked synchronization circuitry and their capture range is not great enough for some computers.

It's interesting to note that an article in the January 1981 Consumer Reports, *"19-inch color TV's" (see page 36), dealt with this phenomenon. Consumers Union tested a number of televisions with an Apple II computer. It found that two models (Zenith and Sylvania) had a "severe vertical jitter, making the display almost unreadable."*

While this is little consolation to you, in your case it may not be your TV. You mentioned the same effect occurred with your computer on a television in a store. Did the store's Color Computer exhibit these bars? If not, you may have a defect in your computer.

In summary, the problem exists with some television sets. Run a swap test with a Color Computer that functions normally and determine where the fault lies. . . . **Steve**

Downloading to CP/M

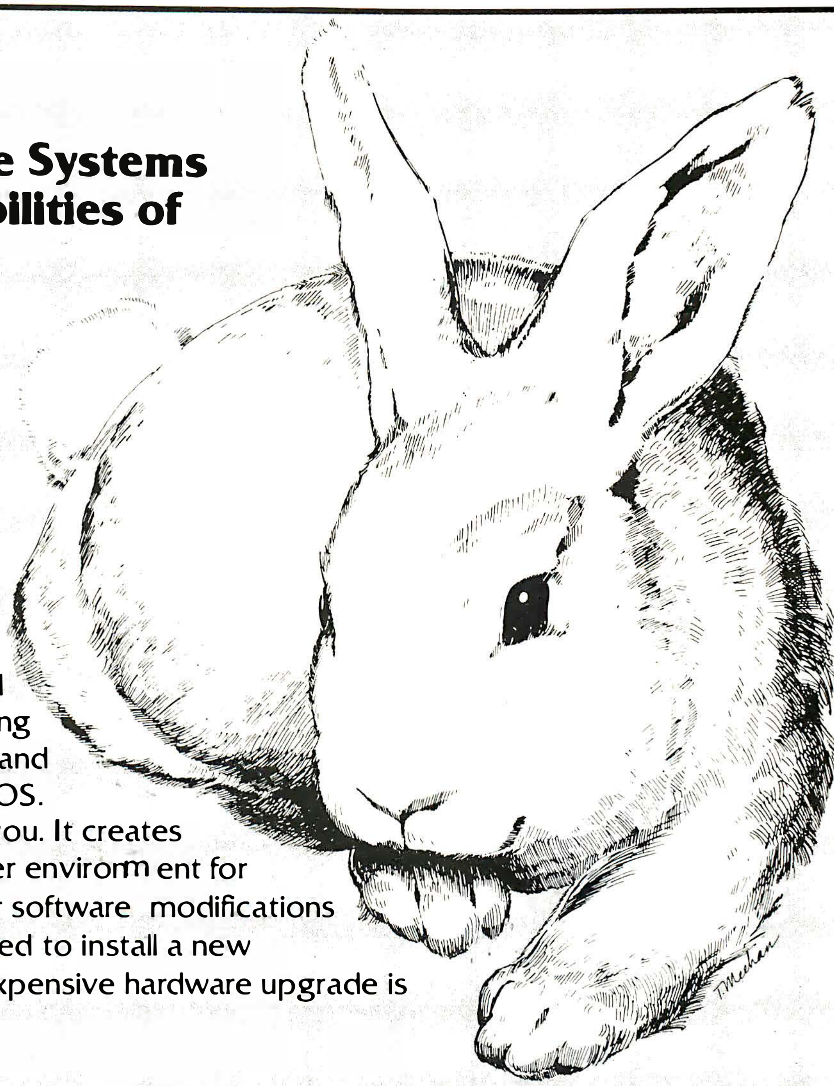
Dear Steve,

A brochure on Visicorp's Visiterm software package claims that it will allow information to be *downloaded* from a larger host computer to an Apple II. Do you know of any similar software packages that will allow downloading to a CP/M-based microcomputer? My company has a Z80-based computer with a Soroc IQ-120 terminal and CP/M 2.2. The host computer is an IBM 360/370.

John E. O'Hare
Tucson, AZ

Lifeboat Associates (1651 Third Ave., New York, NY 10028, (212) 860-0300) sells a utility program, called BSTMS, which allows you to download certain software from a large mainframe computer. BSTMS is available for many CP/M configurations at a cost of $400.

A popular public-domain telecommunications program is Modem73, which is the latest version of a program written by Ward Christensen. Modem73 is available at a low cost from the CP/M User's Group, which can be



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Circle 435 on inquiry card.

contacted via Lifeboat Associates. Winterhalter & Associates Inc. (313 North First St., Ann Arbor, MI 48103, (313) 662-2002) has a number of programs, known as the Micro 3270 family, that emulate an IBM 3270 interactive terminal and the IBM 3780, 2780, 3741, and 2770 remote-job entry terminals. Some of the versions run under CP/M.

Hope this is of some help.
. . . **Steve**

Digital Speedometer

Dear Steve,

I want to build a digital speedometer with a three-digit readout having increments of 5 miles per hour (mph) or even 1 mph. Input pulses can be taken on a one-pulse-to-one-tire-revolution basis directly from the axle or brake drum. My tires have a diameter of about 29½ inches.

I also want to build a digital tachometer with a three-digit readout to display my four-cylinder engine's speed at any range up to 9990 revolutions per minute (rpm). Input pulses can be taken from an engine pulley or from the ignition coil.

I haven't had any luck in locating circuit diagrams for these units. Can you help?

Peter J. Pinette
Yorktown Heights, NY

A circuit for a digital speedometer can be found in the January 1981 "Ask BYTE" (see page 288). The article has enough information to configure one for your purpose. A digital tachometer can be made using the same concepts.

My Circuit Cellar article "DC Motor Controls: Build a Motorized Platform" (May 1981 BYTE, page 66) also contained information on this subject.

Both circuits consist of signal conditioners feeding decade counters with the binary-coded decimal (BCD) outputs converted to drive seven-segment light-emitting diode (LED) displays. If you understand how the various counters work (refer to manufacturer's data sheets), you can tailor the circuits to your specific applications.
. . . **Steve**

Data In, Garbage Out

Dear Steve,

Most people using small computers for hobby or business have experienced garbled data at some time. In my own case, it happens occasionally on data files on my Charles River Data HD11-T, which is hooked to a Heath H-11A (based on the LSI 11/23 microprocessor). The files have been known to be correct beforehand. Unfortunately, there is no indication that something has garbled the file until it is accessed.

I suspect that some sort of power glitch affecting the disk drive is the culprit, but there hasn't been lightning or any indication of power problems while the system

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was operating. Although the power line used by the system is not "dedicated," it is not overloaded.

I'm confused by the various advertisements for "line conditioners," protectors, and regulators. How do you know if you really need one of these things, barring frequent catastrophes, and how do you choose the one suited for your installation? A 1-kilovolt-ampere (kVA) capacity regulator costs about $500, so it would be nice to know it would help before making the purchase. It would even be better to save part of the cost by building it!

James R. Monnahan
Provo, UT

Basically, two types of power-line problems affect computers: voltage transients and voltage fluctuations. Transients tend to place spikes (i.e., short-duration, high-voltage pulses) on the power-supply line. Spikes can raise havoc with a computer. Fortunately, a well-designed and regulated power supply can suppress many of them. Poorly designed power supplies generally fail under a severe transient, usually by means of shorted diodes.

Ordinarily, voltage fluctuations are visible in the form of lights dimming or flashing. The problem here is that if the voltage goes too low, the regulators in the power supply cannot compensate and the voltage in the computer drops below the minimum specifications. The result is garbled data.

On the other end, high line voltages should be taken care of by power-supply regulator circuits. Because a computer's power transformers are usually step-down devices, higher voltages result in an increase in heat dissipation by the regulators.

Line conditioners and protectors are often metal-oxide varistors (MOVs) or zener diodes designed to clip transients above a certain level, which protects circuits downstream. The regulators are designed to maintain the line voltage between prescribed limits.

Which device is required for your computer? I would try to be more aware of the lights dimming or flashing (e.g., when a large motor starts or stops). If this is the case, either add a regulator or eliminate the offending device. Otherwise, try a clipping device. . . . **Steve**

Wanted: RS-232C-to-IEEE-488 Interface

Dear Steve,

I recently assumed a new position at Kenyon College and discovered that some of the scientists on campus have become very frustrated trying to use a Hewlett-Packard HP-9872A Plotter that is attached to an HP-2647 Graphic Terminal. They have managed to learn about handshaking sequences and other protocols, but the problem seems to be the interface. A salesman informed me that the plotter interface is an IEEE-488 and not the RS-232C type that is standard on an Digital Equipment Corporation PDP-11/70.

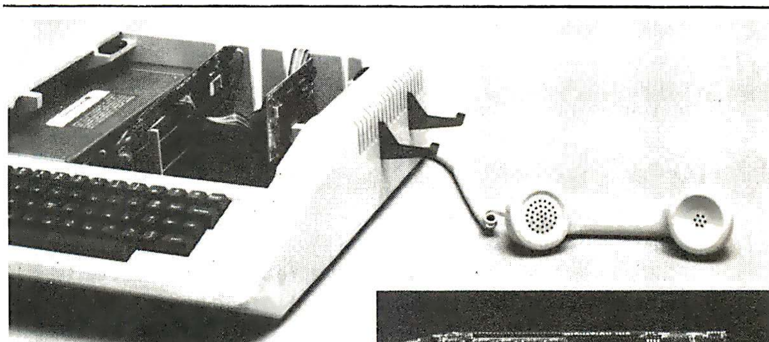
Two solutions are obvious: to replace the plotter with a different model that has the appropriate interface, or to buy or build a "black box" that does bidirectional RS-232C-to-IEEE-488 conversion. Since I'm not truly informed about electronics, I am wondering about the difficulty of making such a black box and about the cost of obtaining one, if I could even locate such a device.

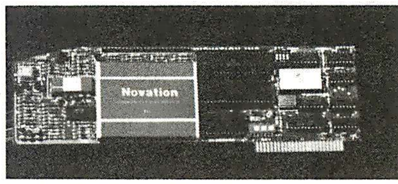
Perhaps you know of someone or some company that has made such a device—or could you give me some estimates on the relative

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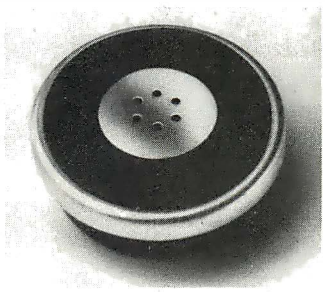
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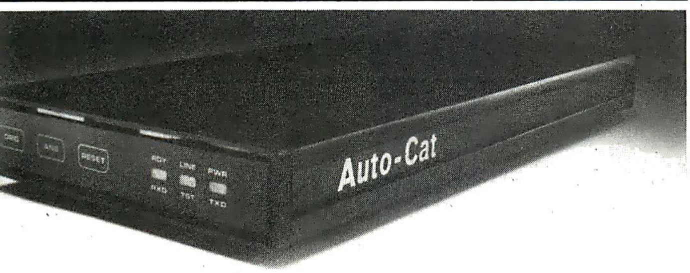
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Circle 307 on inquiry card.

ease or difficulty of building one?

Robert A. Rennert
Kenyon College
Gambier, OH

Any easy solution is always expensive (Murphy's Law) and the cheap solution very hard (again, Murphy's Law). However, don't give up hope.

Your first idea, replace the plotter, is a good one. The Hewlett-Packard 7221A Plotter is the RS-232C equivalent of the 9872A Plotter and it costs about the same. Your second solution is also good. One type of black box on the market is the GPIB (general-purpose interface bus, equivalent to the Hewlett-Packard interface) controller with RS-232C interface. Another is the PDP-11-to-GPIB interface card of which the National Instruments series is a good example.

Finally, building you own interface is less expensive but more difficult than buying one ready-made.

Here are some sources for literature and hardware.

. . . Steve

Fairchild Camera and Instrument Corporation
464 Ellis St.
Mountain View, CA 94042
(Re: 96LS488 GPIB circuit)

Hewlett-Packard Company
9920 Carver Rd.
Cincinnati, OH 45242
(Re: Publications 5952-0058 and 5952-0156)

RS-232C-to-GPIB interface

Physical Data Inc.
8089 Southwest Cirrus Dr.
Beaverton, OR 97005

ICS Electronics Corporation
1620 Zanker Rd.
San Jose, CA 95112

Unibus-to-GPIB interface

National Instruments
Building A-117
8900 Shoal Creek
Austin, TX 78758. ■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

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All in all, they've got the features that make them destined for stardom. But the best part is that beneath this software bonanza beats the

Uh...three legends.

heart of an Epson. So you still get a bidirectional, logical seeking, disposable print head, crisp, clean, correspondence quality printing, and the kind of reliability that has made Epson the best-selling printers in the world.

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Bidirectional printing	X	X	X	X	X	X
Logical seeking function	X	X	X	X	X	X
Disposable print head	X	X	X	X	X	X
Speed: 80 CPS	X	X	X	X	X	X
Matrix: 9 x 9	X	X	X	X	X	X
Selectable paper feed			X		X	X
PAPER HANDLING FUNCTIONS						
Line spacing to n/216		X		X	X	X
Programmable form length	X	X	X	X	X	X
Programmable horizontal tabs	X	X	X	X	X	X
Skip over perforation			X	X	X	X
PRINT MODES AND CHARACTER FONTS						
96 ASCII characters	X	X	X	X	X	X
Italics character font		X		X	X	X
Special international symbols				X	X	X
Normal, Emphasized, Double-Strike and Double/Emphasized print modes	X	X	X	X	X	X
Subscript/Superscript print mode				X	X	X
Underline mode				X	X	X
10 CPI	X	X	X	X	X	X
5 CPI	X	X	X	X	X	X
17.16 CPI	X	X	X	X	X	X
8.58 CPI	X	X	X	X	X	X
DOT GRAPHICS MODE						
Line drawing graphics				X	X	X
Bit image 60 D.P.I.		X	X	X	X	X
Bit image 120 D.P.I.		X	X	X	X	X
CONTROL FUNCTIONS						
Software printer reset		X		X	X	X
Adjustable right margin			X	X	X	X
True back space		X		X	X	X
INTERFACES						
Standard — Centronics-style 8-bit parallel	X	X	X	X	X	X
Optional — RS-232C current loop w/2K buffer	X	X	X	X	X	X
RS-232C x-on/x-off w/2K buffer	X	X	X	X	X	X
IEEE-488	X	X	X	X	X	X

*Tandy TRS-80 block graphics only available with GRAFTRAX 80.

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Circle 165 on inquiry card.

Event Queue

May 1982

May
Courses from Boeing Computer Services, various sites throughout the U.S. Boeing Computer Services is offering a wide variety of computer-related courses at its regional service centers. Course topics range from "Introduction to Data Processing" to "Structured Program Development in FORTRAN." For a complete schedule of times, locations, and fees, contact Boeing Computer Services Co., Education and Training Division, POB 24346, Seattle, WA 98124, (206) 575-7700.

May
Courses in Structured Systems, various sites throughout the U.S. Courses in "Structured Systems Design," and "Structured Requirements Definition" are being offered by Ken Orr and Associates. For information on meeting times, places, and fees, contact Ken Orr and Associates Inc., 715 East 8th, Topeka, KS 66607, (800) 255-2459; in Kansas, (913) 233-2349.

May
Courses from George Washington University, San Jose, CA; Washington, DC; Mexico City, Mexico; and Berlin, West Germany. Among the courses scheduled are "Computer Performance Evaluation," "Workshop in Data Communications for Microcomputers," and "Microcomputer Applications Workshop." Fees range from $590 to $760. Contact Continuing Engineering Education, School of Engineering and Applied Science, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-6106.

May
Seminars and Conferences from Datapro Research, various sites throughout the U.S. Among the topics to be presented are "IBM's Systems Network Architecture," "Data Dictionary/Directory Systems," and "Data Processing: Fundamental Concepts." Enrollment fees are $640 for Datapro subscribers and $690 for nonsubscribers. For a complete catalog with descriptions, dates, and locations, contact Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

May
Technology Transfer Institute Seminars, Washington, DC, and San Francisco, CA. "Fundamentals of Database Management," "Fundamentals of Data Structures," and "X.25 and Other Protocol Interfaces" are among the seminars being offered. Contact Technology Transfer Institute, 741 10th St., Santa Monica, CA 90402, (213) 394-8305.

May-June
Intensive Two-day Seminars for Professional Development, various sites throughout New England. Among the seminars to be offered by Worcester Polytechnic Institute are "Fundamentals of Data Processing," "Distributed Systems: The Architecture and Utilization of this Revolutionary Technology," and "Microprocessors: Hardware, Software, and Applications." Registration fees range from $445 for a two-day program to $990 for a seven-day executive institute. For complete details, contact Ms. Ginny Bazarian, Office of Continuing Education, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517.

May-June
Cooperative Education Program, various sites throughout the U.S. This series of more than 100 data-processing courses is presented by Q.E.D. Information Sciences Inc. Course topics include systems development, structured methodologies, database, telecommunications, management, and human relations. These two- to five-day courses are tailored for analysts, designers, programmers, managers, and other users. For additional details, contact the Manager of Education Programs, Q.E.D Information Sciences Inc., Q.E.D. Plaza, POB 181, Wellesley, MA 02181, (800) 343-4848; in Massachusetts, (617) 237-5656.

May-June
Courses and Seminars from Sira Institute, various sites throughout England. Sira Institute is sponsoring seminars on a wide variety of subjects, ranging from microprocessor familiarization to design and development of microprocessor-based equipment. For details, contact Conferences & Courses Unit, Sira Institute Ltd., South Hill, Chislehurst, Kent BR7 5EH, England.

May-June
National Computer Graphics Association Seminar Program, various sites throughout the U.S. Topics include "Computer Graphics: Technology and Applications," "Successful Business Graphics," and "Applications of Computer Graphics to Transportation Problems." Seminar fees are $395 for association members and $425 for nonmembers. For complete details, contact Eloise Wenker, NCGA Seminar, 2033 M St. NW, #300, Washington, DC 20036, (202) 466-4102.

May-June
Datamation Institute Seminars on Information Management, various sites throughout the U.S. Databases and communications, systems performance, data-processing management, word processing, office automation, computer graphics, and topics of general interest are among the areas to be covered by these two-day seminars. Fees range from $495 to $595. For schedules of times and places, contact Karen Smolens, the Center for Management Research, Datamation Institute Seminar Coordination Office, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020.

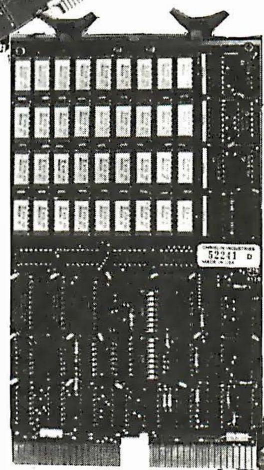
May-June
Education and Training Seminars, various sites throughout the U.S. and Europe. Among the seminar topics offered by STSC Inc. and APL*Plus International are "Nested Arrays," "Intermediate APL," and "Advanced APL Programming Techniques." For complete details on these and other seminars, contact the Seminar Administrator, STSC Inc., 11 Clearbrook Rd., Elmsford, NY 10523, (914) 347-5560. In Europe, contact APL*Plus International, Tour Neptune, Cedex N°20, 92086 Paris La Défense, France, Tel: 773.79.64.

May-June
The Master Method of Selling Small-Business Systems, Westlake Village, CA. This one-day seminar is designed for mini- and microcomputer manufacturers and software vendors who sell small-business systems. The seminar fee is $150. For details, contact Seminar Information, M. W. L. Inc., 32038 Watergate Court, Westlake Village, CA 91361, (213) 889-2607.

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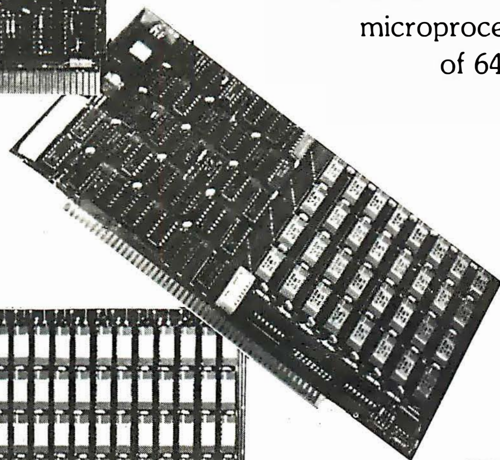




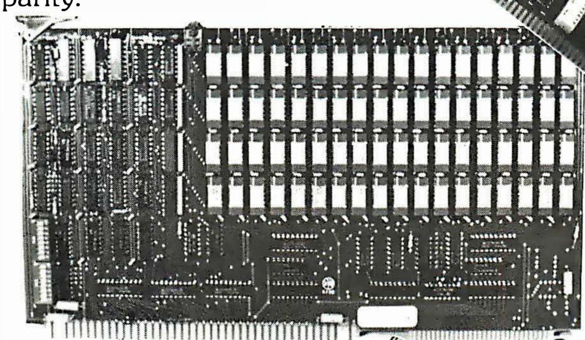
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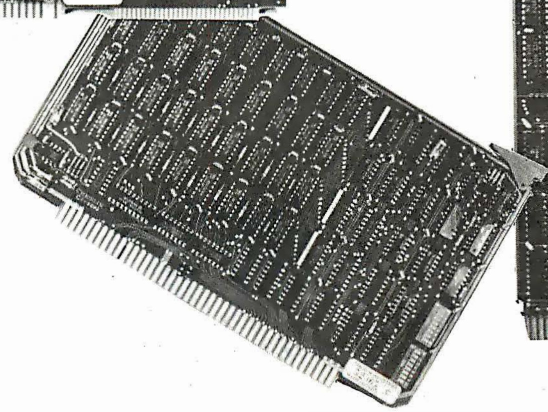


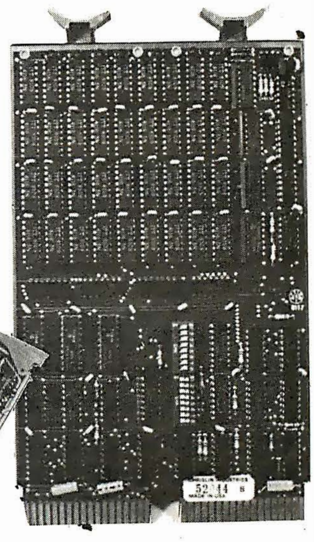
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May-June

Productivity '82, various sites throughout the U.S. and Canada. This two-day show features hands-on demonstrations of Hewlett-Packard's newest computer and application solutions ranging from personal and small-business computers to the top-of-the-line computer systems for office computing, distributed data processing, and factory automation. Sixteen different seminars are held each day on such topics as using personal computers, choosing financial and applications software, and preparing easy-to-read graphics. Additional information can be obtained from local Hewlett-Packard sales offices or from Rudanne Clark, Hewlett-Packard, 3000 Hanover St., Palo Alto, CA 94304, (415) 857-7247.

May-June

Sensors & Systems '82, various sites throughout the central and western regions of the U.S. This series of three-day conferences will cover all aspects of sensor technology from temperature sensors through to displacement, velocity, acceleration, magnetic field, and moisture. Other topics to be covered include signal conditioning, digital interfaces, and system interfaces. Contact Network Exhibitions, 785 Harriet Ave., Campbell, CA 95008, (408) 370-1661.

May-July

Computerized Robots, various sites throughout the U.S. This four-day course is tailored for managers concerned with the planning and design of advanced manufacturing methods and for those who will be involved with the development and integration of high-technology robot systems. Course topics include the extent of robot automation in the U.S., Japan, and Europe; technical capabilities and limitations of robots; robot sensory mechanisms, vision, touch, proximity; and programming techniques for robot control. The course fee is $845. For details, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

May-July

Meetings, Seminars, and Programs from the Electronic Industries Association (EIA), various sites throughout the U.S. Among the events planned are the Electronic Components Conference, the Government/Industry Executive Roundtable '82, and a symposium on "Telecommunications: Trends and Directions." Contact EIA, 2001 Eye St. NW, Washington, DC 20006, (202) 457-4981.

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May-July
Speech Synthesis and Recognition, various sites throughout the U.S. This four-day seminar is for product development and design engineers, systems analysts, programmers, and technical managers who will be involved with the planning, design, and implementation of voice input/output (VIO) systems. Among the topics to be covered are understanding voice-processing algorithms and software, evaluating available VIO hardware components and systems, and using speech-synthesis techniques. In-class presentations of VIO systems, components, and techniques will illustrate discussions. The course fee is $795. Contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

May-July
Structured Design and Programming, various sites throughout the U.S. This four-day course emphasizes the development of skills that facilitate the efficient production of reliable, well-documented, and maintainable programs, on time and within budget. Some of the topics to be addressed are structured software design methods, how to write structured programs for mini- and microcomputers, and how to improve program readability and reliability. The course fee is $795. Contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

May-July
Technical Classes from Zilog, Campbell, CA. Zilog is offering a series of one- to five-day technical classes at its California-based training facility. Topics range from "Microprocessors: A General Introduction" to "Zeus/System 8000 User." Contact Zilog, Training and Education Dept., 1315 Dell Ave., Campbell, CA 95008, (408) 446-4666.

May-July
Computer Network Design and Protocols, various sites throughout the U.S. This four-day course will focus on the practical aspects of network design, interfacing, protocols, and packet switching. Among the topics to be covered are how to determine system requirements and perform design trade-offs, how to carry out network communication and control protocols, and how to evaluate available network hardware and software components. The course fee is $845. For complete details, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

May-August
Engineering Summer Conferences, Chrysler Center for Continuing Engineering Education, North Campus, University of Michigan, Ann Arbor, MI. Among the conferences being offered are "Interactive Design with Computers," "Applied Numerical Methods," and "Robotics: Concepts, Theory, and Applications." For complete details, contact Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109, (313) 764-8490.

May 9-12
The Seventeenth Annual Meeting of the Association for the Advancement of Medical Instrumentation (AAMI), Hyatt Regency Embarcadero, San Francisco, CA. Approximately 50 scientific and technical sessions will explore such topics as nuclear magnetic resonance imaging, computerized data management for surgical anesthesia monitoring, and patient data management. Exhibits will be featured. For details, contact the AAMI, Suite 602, 1901 North Fort Myer Dr., Arlington, VA 22209, (703) 525-4890.

May 10-12
Dexpo 82, Marriott Hotel, Atlanta, GA. This exposition features DEC- (Digital Equipment Corporation) compatible hardware, software, and services. Contact Expoconsul International Inc., 19 Yeger Rd., Cranbury, NJ 08512, (609) 799-1661.

May 10-13
The Annual Meeting and Technical Conference of the IEEE Industrial Power Systems Department, Marriott Hotel, Philadelphia, PA. For details, contact Dr. Paul Reece, General Electric Co., 6901 Elmwood Ave., Mail Drop 06302, Philadelphia, PA 19142, (215) 726-2800.

May 10-14
Introduction to Microprocessor Systems Engineering, University of Tennessee Space Institute, Tullahoma, TN. For details, contact Jules Bernard, University of Tennessee Space Institute, Tullahoma, TN 37388, (615) 455-0631, ext. 278.

May 10-14
The Twentieth Annual Convention of the Association for Educational Data Systems (AEDS), Sheraton Twin Towers, Orlando, FL. This convention includes presentations on the state of the art in educational computing. Administrative and instructional computing applications will be presented, and new ways

of improving educational processes will be explored. Contact AEDS, 1201 Sixteenth St. NW, Washington, DC 20036, (202) 833-4100.

May 11

DEC-Compatible Show, Omni International, Atlanta, GA. This conference for Digital Equipment Corporation (DEC) users is sponsored by MDB Systems. It is designed to provide users with selection assistance and application support for a wide range of products. Contact MDB Systems Inc., 1995 North Batavia St., Orange, CA 92665, (714) 998-6900.

May 14-15

The Second Annual Southern California Computers-in-Education Conference, University High Scool, Irvine, CA. This conference covers the application of computers in education from kindergarten through two-year college. All areas of curriculum will be covered, including reading, mathematics, science, language, and special education. Hands-on workshops and field trips are planned. Contact Craig Walker, Arrowview Intermediate School, 2299 North G St., San Bernardino, CA 92405, (714) 886-9118.

May 14-16

Applefest/Boston, Hynes Auditorium, Boston, MA. This show will feature more than 200 displays and booths of Apple-compatible products and accessories. Seminars and panel discussions will be held. Ticket prices are $6 per day or $15 for a three-day pass. Contact National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167, (617) 739-2000.

May 15-16

The North American Computer Othello Championship, Learning Resources Center, Andersen Hall, Northwestern University, Evanston, IL. This two-day tournament is sponsored by the United States Othello Association. Champions will be determined in three categories: microcomputer systems (located on site), mainframe systems (telephone hookup), and special-purpose Othello machines. For complete tournament details, write to Professor Peter W. Frey, Dept. of Psychology, Northwestern University, Evanston, IL 60201.

May 16-21

Advanced DP Training Management Workshop, Los Angeles, CA. This workshop is intended for training managers directly responsible for planning, monitoring, and evaluating data-processing training and reporting to upper-level management. The prerequisite for this workshop is completion of Deltak's Training Managers' Workshop (see May 23-28) and a minimum of one year's experience since completion or the equivalent on-the-job experience. The registration fee is $850. Contact Linda Hubacek, Deltak Inc., 1220 Kensington Rd., Oak Brook, IL 60521, (312) 920-0700.

May 17-21

Graphics Interface 82, Toronto, Ontario, Canada. This conference and exhibition is sponsored by the Canadian Man-Computer Communications Society and the National Computer Graphics Association of Canada. Papers and speakers will address a wide variety of topics, including man-computer interaction, animation, graphics algorithms, and computer-aided design and manufacturing. For details, contact Rich MacKay, Dataplotting Services Inc., 160 Duncan Mills Rd., Don Mills, Ontario M3B 1Z5, Canada, (416) 447-8518.

May 18-20

Microcomputers in Education, Gutman Library, Cambridge, MA. This series of workshops is designed for educators at all levels. Topics include an overview of the educational uses of microcomputers, BASIC and graphics, Pascal, and the administrative uses of microcomputers. Hands-on experience will be emphasized. For information, contact Technical Education Research Centers, 8 Eliot St., Cambridge, MA 02138, (617) 547-3890.

May 18-20

Northcon/82 High-Technology Electronics Exhibition and Convention, Seattle Center Coliseum, Seattle, WA. Contact Electronics Conventions Inc., 999 North Sepulveda Blvd., El Segundo, CA 90245, (800) 421-6816; in California, (213) 772-2965.

May 19-21

Computer Hong Kong 82, Regent Hotel, Hong Kong. This three-day program, which embraces the Fifth Hong Kong Computer Conference, will focus on the electronic data-processing market. For further details, contact Kallman Associates, 5 Maple Court, Ridgewood, NJ 07450, (201) 652-7070.

May 20-21

The Third Annual Computer Law Institute, Los Angeles, CA. This institute will provide an in-depth program on antitrust, proprietary rights, and contractual issues confronting the computer industry. Among the topics to be covered are fair trade practices and the negotiation and structuring of distributor, dealer, and original equipment manufacturer contracts. Contact Ami Silverman, University of Southern California Law Center, University Park, Los Angeles, CA 90007, (213) 743-2582.

May 20-21

The Third Annual Electronic Mail Seminar, BBN Conference Center, Cambridge, MA. This seminar is designed for anyone investigating, planning, implementing, or expanding computer-based message systems. The technical, social, and managerial issues involved in a successful electronic mail program will be studied. Hands-on experience will be provided. Contact BBN Information Management Corp., 10 Moulton St., Cambridge, MA 02238, (617) 497-2929.

May 21-23

The 1982 Computer Showcase Expo, Boston, MA. The Computer Showcase is designed for small-business owners, independent professionals, and corporate managers. Admission is $7.50. For further details, contact the Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

May 22

The First Regional Conference on Technology and Special Education, Mill Neck Manor Lutheran School for the Deaf, Mill Neck, NY. Sponsored by the New York State Association for Educational Data Systems, this conference will focus on computer applications in special education for administrators, teachers, and parents. Contact Dr. Dolores Shanahan, Commack Public Schools, Indian Hollow Computer Laboratory, Kings Park Rd., Commack, NY 11725, or Jerry Burke, Half Hollow Hills High School, Dix Hills, NY 11746.

May 22

The Third Annual New Jersey Microcomputer Show & Flea Market, Holiday Inn (North), Newark International Airport, Newark, NJ. This event will feature more

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May 23-28
DP Training Managers' Workshop, Dallas, TX. This workshop is intended for individuals with less than 18 months' experience in coordinating data-processing training programs. Participants will learn to establish in-house education programs that will meet management objectives and ensure a high return on their organization's investment in training. The registration fee is $850. Contact Linda Hubacek, Deltak Inc., 1220 Kensington Rd., Oak Brook, IL 60521, (312) 920-0700.

May 25-27
Electro/82 High-Technology Electronics Exhibition and Convention, Hynes Auditorium, Commonwealth Pier, and Sheraton-Boston Hotel, Boston, MA. Contact Electronics Conventions Inc., 999 North Sepulveda Blvd., El Segundo, CA 90245, (800) 421-6816; in California, (213) 772-2965.

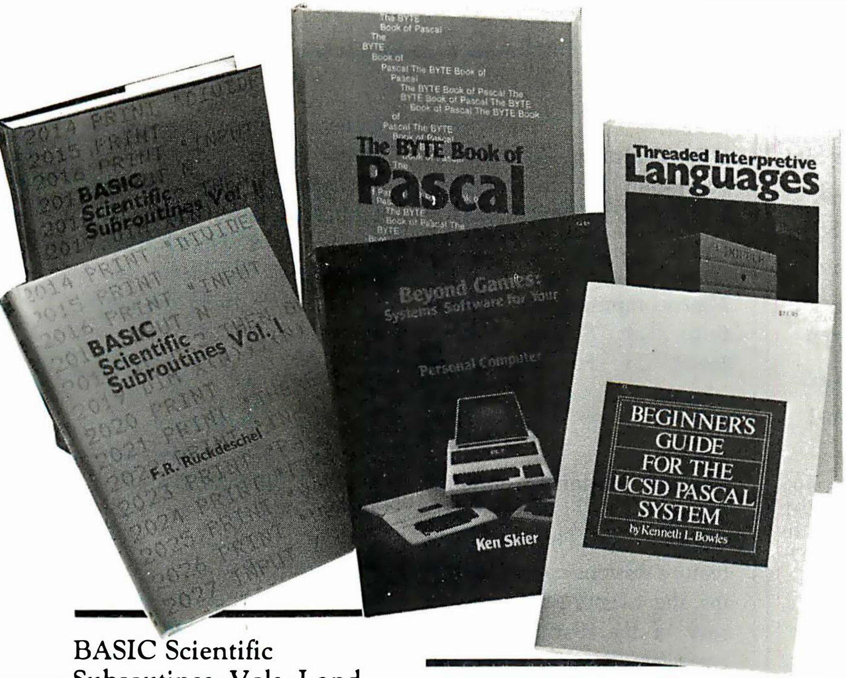
May 31-June 4
Personal Microcomputer Interfacing and Scientific Instrument Automation, Virginia Polytechnic Institute and State University, Blacksburg, VA. This workshop is designed to teach users how to interface and use personal computers in instrumentation and automation systems. Hands-on experience working with and designing interfaces for personal computers will be featured. Contact Dr. Linda Leffel, CEC, Virginia Tech, Blacksburg, VA 24061, (703) 961-4848.

June 1982

June
Knowledge Engineering in the 1980s, Chicago, IL. Expert Systems are computer programs that reason in tasks requiring considerable human expertise, such as locating computer malfunctions, monitoring intensive care patients, analyzing noisy signal data, and diagnosing medical problems. This one-day executive briefing provides an introduction to the potential benefits and costs of Expert Systems. For further information, contact Dina Barr, Teknowledge, 151 University Ave., Palo Alto, CA 94301, (415) 326-6827.

June-August
Database Concepts and Design, various sites throughout the U.S. Sponsored by the American Management Associations (AMA), this five-day seminar is designed for data-processing managers, system designers, and other personnel involved in database activities. Topics include an overview of the database environment; evaluating and measuring performance, costs, and results; determining organizational needs and the systems software to meet them; and implementing, integrating, and supporting the database within company plans and budget. Highlighting this seminar is a comprehensive review of database products. Individual fees are $850 for AMA members and $975 for nonmembers. Team discounts are available. Contact AMA, 135 West 50th St., New York, NY 10020, (212) 586-8100. To register by phone, call (212) 246-0800.

June 6-11
Advanced DP Training Management Workshop, Calgary, Alberta, Canada. For details, see May 16-21.



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by Kenneth L. Bowles

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Event Queue

June 6-11
DP Training Managers' Workshop, Philadelphia, PA. For details, see May 23-28.

June 7-9
Microcomputers in Education, Taft School, Watertown, CT. For details, see May 18-20.

June 7-10
The 1982 National Computer Conference, Astrohall, Houston, TX. This show will feature sessions commemorating the twenty-fifth anniversary of the first FORTRAN compiler. For more details, contact the American Federation of Information Processing Societies Inc., 1815 North Lynn St., Arlington, VA 22209, (703) 558-3612.

June 7-11
The Eleventh Annual Meeting of the MUMPS Users' Group, Denver Hilton Hotel, Denver, CO. This conference will embrace a wide assortment of topics relating to the MUMPS computer language, including medical and business applications, small and large MUMPS systems, technical issues, and new areas of opportunity. Roundtable discussions, workshops, and tutorials for new and experienced programmers will be held. Hardware, software, and systems will be exhibited. Contact the 1982 MUMPS Users' Group Meeting, POB 37247, Washington, DC 20013, (301) 779-6555.

June 9-11
The International Conference on Consumer Electronics (ICCE), Arlington Park Hilton, Arlington Heights, IL. The technical program will include papers and panel discussions on such topics as personal computing, computer-aided design techniques, home information systems, and videotex, teletext, videodisc, video-cassette recorders, and cameras. Exhibits will be featured. This conference is sponsored by the Consumer Electronics Group of the IEEE (Institute of Electrical and Electronics Engineers). Contact the IEEE, 445 Hoes Lane, Piscataway, NJ 08854.

June 13-16
The Fifteenth Annual Conference of the Association of Small Computer Users in Education, Chatham College, Pittsburgh, PA. This conference will include papers and demonstrations on the educational and administrative uses of computers. Other topics to be covered are robotics, Pascal programming, computer literacy, and the use of packaged software in computer courses. For more information, contact Jan Carver, Computer Center, Chatham College, Pittsburgh, PA 15232, (412) 441-8200.

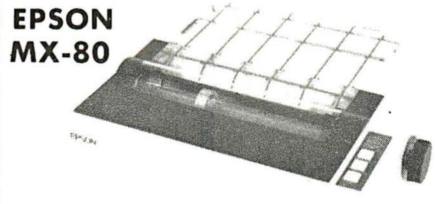
June 14-16
The Fifteenth Power Modulator Symposium, Hyatt Regency Baltimore, Baltimore, MD. This symposuim will focus on the technology, devices, and systems associated with rep-rated power modulators, including switches, auxiliary devices, energy storage, radio-frequency systems, and low-frequency generators. For details, contact Leonard Klein, Palisades Institute for Research Services Inc., 201 Varick St., New York, NY 10014, (212) 620-3377.

June 15-17
The 1982 IEEE MTT-S International Microwave Symposium, Hyatt Regency Hotel, Dallas, TX. The theme of this symposium is "Thirty Years of Microwaves." Papers and tutorials on a wide range of topics, including computer-aided design and measurement techniques, microwave field and network theory, as well as satellite communica-

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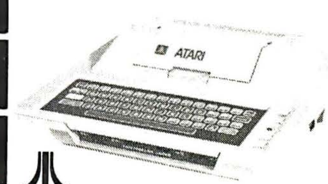
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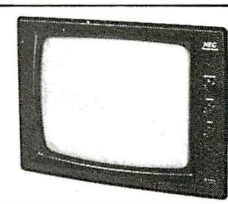


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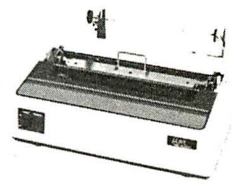
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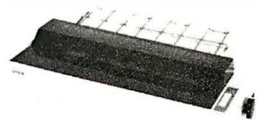
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June 15-17
The Office Automation Show/Conference, Barbican Centre, London, England. For details on this show and conference, contact Clapp & Poliak International, 7315 Wisconsin Ave., Washington, DC 20014, (301) 657-3090.

June 16-18
The Twentieth Annual Meeting of the Association for Computational Linguistics, University of Toronto, Toronto, Ontario, Canada. This meeting features papers on syntax, computational semantics, discourse analysis and speech acts, machine translation, as well as the mathematical and theoretical foundations of computational linguistics. For additional information, contact Don Walker, Artificial Intelligence Center, SRI International, Menlo Park, CA 94025, (415) 859-3071.

June 20-25
DP Training Managers' Workshop, Chicago, IL. For details, see May 23-28.

June 23-26
Productivity 82, Seattle University, Seattle, WA. This conference is sponsored by the Association for Computing Machinery (ACM) and the Canadian Information Processing Society (CIPS). Productivity 82 is designed to emphasize the use of computers to improve productivity in industry and in the office, as well as to improve productivity in the programming of computers. Papers and panel discussions will be featured. For more information, contact Productivity 82-ACM/CIPS, 10636 Main St. #276, Bellevue, WA 98004.

June 28-30
COMDEX/Spring '82, Atlantic City Convention Hall, Atlantic City, NJ. For details on this conference and exhibition, contact the Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

June 28-30
National Educational Computing Conference (NECC-82), Radisson-Muehlebach Hotel, Kansas City, MO. This conference features papers, sessions, panel discussions, and exhibits of educational computing products. Among the topics to be addressed are "Computer Use in the Physical Sciences," "Computer Education for Teachers," and "Computer Science, Engineering, and Information Systems Education." For more information, contact E. Michael Staman, NECC-82 General Chairman, Computer Services, 305 Jesse Hall, University of Missouri-Columbia, Columbia, MO 65211.

July 1982

July 11-15
The International Manufacturing Systems Conference '82, Convention Center, Buffalo, NY. The conference theme is "The Technology of Productivity." More than 100 experts will conduct seminars on a wide variety of topics. Exhibits, vendor presentations, and plant tours are planned. Contact Roy Combs, International Manufacturing Systems Conference, 186 North Water St., Rochester, NY 14604, (716) 232-3950.

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July 13-14
Controlling Electromagnetic Interference, Hyatt Hotel at LA Airport, Los Angeles, CA. This seminar is sponsored by *Electronics* magazine, a McGraw-Hill publication, and is designed for electronics industry professionals who must make technical or cost decisions based on an understanding electromagnetic interference. Topics of discussion include intersystem problems, designing against environmental noise, how to determine the best frequency for a given application, and the structure and use of intrasystem electromagnetic compatibility models. The fee is $595; inplant programs can be arranged. Contact Ms. Barbara Bancroft, McGraw-Hill Seminar Center, Room 3112, 305 Madison Ave., New York, NY 10017, (212) 687-0243.

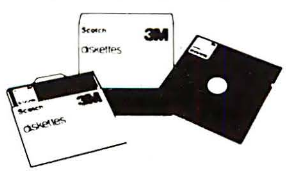
July 18-22
The Fourth General Assembly of the World Future Society, Sheraton Washington Hotel, Washington, DC. The conference theme is "Communications and the Future." All areas of the communications field from telecommunications to interpersonal communication will be covered. The impact of new technologies on society will be explored. Contact the World Future Society, 4916 St. Elmo Ave., Bethesda, MD 20814, (301) 656-8274.

July 19-21
Summer Computer Simulation Conference (SCSC), Marriott City Center Hotel, Denver, CO. The SCSC covers all aspects of computer simulation methodology and applications. Technical sessions and presentations on mathematical methods, model design, simulation languages, and validation techniques will be featured. Information is available from Harvery Marks or Philicia Marks, Transaction Technology Inc., 7648 Capistrano Ave., Canoga Park, CA 91304, (213) 346-5376.

July 21-23
The Computer: Extension of the Human Mind, Eugene Hilton Hotel, Eugene, OR. Sponsored by the University of Oregon College of Education, this conference will feature workshops, speakers, and presentations on the use of computers in education. Topics of interest include preparing teachers to teach with computers, the ethical and social issues associated with computers, and how computers assist learning. The conference fee is $95; students enrolled in the university's summer session can register for $55 and earn a single credit hour. For additional information, contact Judy Ohmer, College of Education, University of Oregon, Eugene, OR 97403, (503) 686-3405.

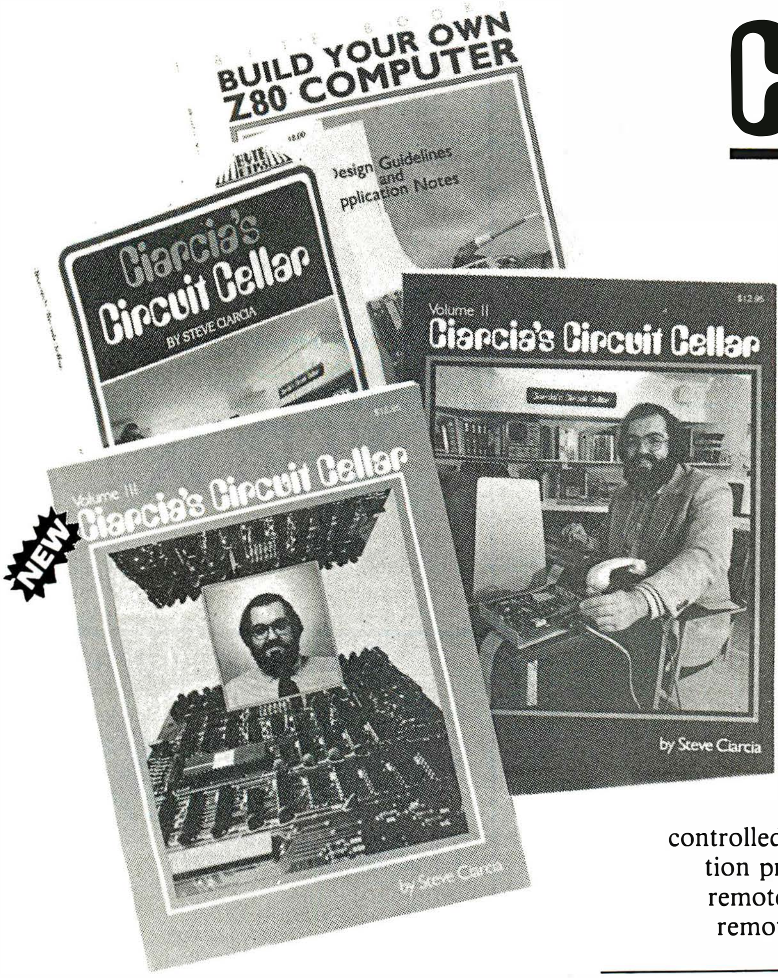
July 25-31
Family Computer Camp, Clarkson College, Potsdam, NY. Each member of your family can gain skill with computers while participating at his or her own level (beginner to expert) and age group (ranging from age 5 to adult). Among the topics to be covered in laboratory and lecture sessions are BASIC programming, word processing, graphics, and home and recreational computer use. Additional details are available from the Conference and Information Center, Clarkson College, Potsdam, NY 13676, (315) 268-6647. ■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.





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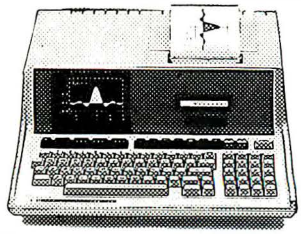
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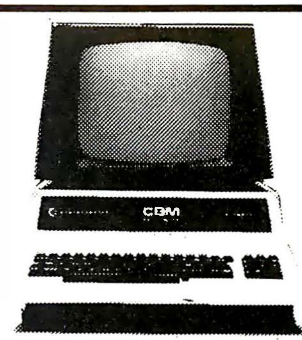
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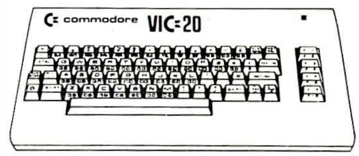


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CHEDIT

A Graphics-Character Editor

Define your own character set for Apple Pascal.

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Apple's Pascal system provides the graphics character set SYSTEM.CHARSET, which is manipulated with the TURTLEGRAPHICS procedures WSTRING, WCHAR, and CHARTYPE. These procedures allow you to employ limited graphics text on displays when the various hardware modes (text only, graphics only, and partially mixed text and graphics as described in the manuals) are insufficient. However, no presently supplied program allows you to edit the character set. Therefore, you are stuck with those characters defined by Apple, as nice as they may be. Herein lies a remedy.

The CHEDIT program allows editing of Apple-format graphics character sets (see listing 1). Although the program is easy to use, it has a number of idiosyncrasies because of its short implementation time. It is not entirely orthogonal and does not contain bulletproof input procedures.

The format of CHEDIT is loosely based on a program of the same name written for the Terak 8510a microcomputer by Keith Allan Shillington. His program was reasonably fast because it used all kinds of UCSD Pascal magic and byte-manipulation intrinsic procedures. However, there was no documentation available internal or external to the program, making it difficult to understand. In contrast, CHEDIT is quite slow in spots, but quite easy to read and understand.

Execution

Because the program uses TURTLEGRAPHICS procedures, the SYSTEM.LIBRARY must be online when CHEDIT is executed. In addition, since the program makes use of the SYSTEM.CHARSET file for prompts, it too must be online. If you are using a nongraphic display (e.g., an 80-column CRT), make sure that the graphics-output device is hooked up (i.e., your TV set). When everything is in order, execute the program (enter X followed by CHEDIT). You are confronted with the prompt INPUT FILE. Then, you must give the name of a file containing a graphics character set. Initially, this will probably be SYSTEM.CHARSET. You are then asked for the name of the output file. I suggest something like TEMP.CHARSET for starters, unless you have something specific in mind, like APL.CHARSET.

Once these preliminaries are out of the way, an 8-row by 16-column character menu is set up in the lower center portion of the screen, an 8-row by 7-column editing pallet is set up in the upper right-hand portion, and a new prompt appears in the upper left-hand portion. This is your cue to select a character for editing (see table 1 on page 440).

Character Selection

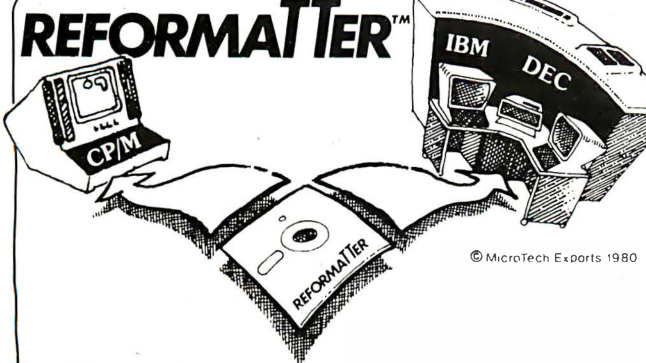
The prompt at this stage is ABORT, QUIT, MAKE CHARACTER. The appropriate replies are A, to abort the program and editing (you are asked to confirm this with Y or N); Q, to terminate editing and save the result in the output file; and M, to perform character selection and editing.

Once you have typed M to make a character, the prompt '.' ACCEPTS, UP, DOWN, LEFT, RIGHT appears accompanied by a flashing cursor that is placed initially in the upper left-hand corner of the character menu. Two methods are used to

Text continued on page 440

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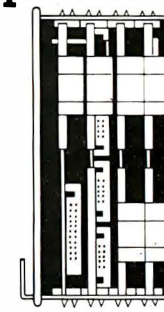
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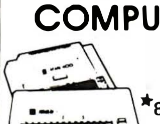
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74LS03	.24	74LS90	.60	74LS170	1.55
74LS04	.24	74LS91	.85	74LS174	.85
74LS05	.24	74LS92	.65	74LS175	.85
74LS06	.30	74LS93	.60	74LS190	.90
74LS08	.28	74LS95	.80	74LS191	.90
74LS10	.24	74LS107	.38	74LS221	1.10
74LS11	.33	74LS109	.38	74LS240	.95
74LS12	.33	74LS112	.40	74LS241	.95
74LS13	.45	74LS113	.40	74LS244	.85
74LS14	.89	74LS114	.45	74LS245	1.65
74LS20	.24	74LS122	.40	74LS248	1.00
74LS21	.24	74LS123	.85	74LS249	.90
74LS26	.30	74LS125	.90	74LS251	1.20
74LS27	.28	74LS126	.85	74LS253	.80
74LS28	.32	74LS132	.70	74LS257	.80
74LS30	.24	74LS136	.50	74LS258	.80
74LS32	.32	74LS138	.65	74LS259	1.25
74LS37	.50	74LS139	.65	74LS260	.60
74LS38	.32	74LS145	1.10	74LS273	1.50
74LS42	.50	74LS151	.70	74LS275	3.00
74LS48	.70	74LS153	.70	74LS279	.50
74LS51	.24	74LS157	.70	74LS283	.75
74LS55	.35	74LS158	.70	74LS373	.90
74LS74	.35	74LS161	.85	74LS374	1.50
74LS75	.48	74LS162	.85	74LS377	1.40
74LS76	.38	74LS163	.85		
74LS78	.50	74LS164	.85		

7400 SERIES

Part	Price	Part	Price
7400	.18	7454	.19
7402	.18	7470	.30
7404	.18	7472	.25
7406	.21	7474	.30
7408	.23	7475	.40
7409	.18	7476	.30
7410	.18	7480	.55
7411	.22	7481	1.00
7412	.28	7489	3.95
7413	.32	7490	.30
7414	.45	7491	.35
7416	.24	7492	.45
7417	.24	7494	.60
7420	.18	7495	.50
7421	.30	74100	.90
7425	.25	74107	.25
7427	.25	74122	.40
7430	.18	74125	.40
7432	.25	74144	2.50
7438	.25	74145	.50
7440	.18	74148	1.00
7442	.45	74154	1.00
7443	.60	74157	.45
7444	.60	74160	.80
7445	.60	74161	.80
7447	.60	74166	.90
7448	.60	74174	.80
7450	.18	74181	1.95
7451	.18	74393	1.00
7453	.19		

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Part	Price	Qty
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2114L 200NS	2.25	4/2.00ea
HM6116 200NS	11.50	4/10.50ea

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Part	Price	Part	Price
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74S02	.38	74S112	1.45
74S03	.38	74S132	1.10
74S04	.45	74S138	.95
74S05	.65	74S140	1.25
74S08	.40	74S158	1.25
74S10	.55	74S174	.95
74S15	.55	74S175	.95
74S20	.55	74S181	4.00
74S22	.75	74S182	2.75
74S30	.35	74S188	3.50
74S37	1.25	74S240	3.50
74S51	.60	74S244	3.50
74S65	.95	74S471	9.50
74S74	.55	74S472	15.00
74S85	2.00		

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8T28	1.20
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8080A	3.75
8155	10.50
8255	4.50
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MC1350	1.15
MC1358	1.50
MC1458	.55
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LM386	1.40
LM565	.95
LM741	.25
LM1310	2.90
LM1800	2.95
LM1889	1.45

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TMS2716	8.95	8/8.00ea
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10/9.70	20	10/2.70
10/12.70	22	10/2.70
10/13.70	24	10/2.70
10/14.70	28	10/3.00
10/17.70	40	10/3.90
wirewrap		solder

Circle 114 on inquiry card.

Listing 1: *The CHEDIT program listing, designed for the Apple II. The program requires 48K bytes of memory, the Language System card, and the Apple Pascal package.*

```
{$S+}
program MakeGraphicChars;
{version [3], June 21, 1981 by Jerry Sweet}
uses TurtleGraphics;  {kindly provided by Apple Computers, Inc.}

const xmin = 0;  ymin = 0;  xmax = 279;  ymax = 191;  {screen parameters}
      xboxcorner = 216;  yboxcorner = 119;             {exploded character box}
      HellFreezesOver = false;
      CharRows = 8;         {number of rows of characters}
      TopRow = 6;           {top-most row of display}
      CharsPerRow = 16;     {number of characters per row}
      xblocksize = 12;      yblocksize = 13; {"logical" character block size}
      xbmax = 11;           ybmax = 12;       {sizes less one}

title = 'Graphic character generator, version [3], 25-Jun-81';

type legalset = set of char;

     onebit = 0..1;
     block = packed array [0..7, 0..7] of onebit;
     cblock = packed array [0..ybmax, 0..xbmax] of onebit;
     charimage = packed array [0..7] of 0..255;
     Charset = packed array [0..127] of charimage;
     Charfile = file of Charset;

     color = (fblack, fwhite);  {turtle graphics uses 'black' and 'white'}
     ortho = (horizontal, vertical);

var filler : array [color] of cblock;  {exploded character 'bits'}
    filename, cnum : string;
    icfile, cfile : Charfile;
    selx, sely : integer;

  procedure wrxy (x, y : integer);
  { places the turtle at the logical character position (x, y), where
    (0, 0) is the at the top-left corner of the screen }
  begin
    if x < 0 then x := 0 else if x > 39 then x := 39;
    if y < 0 then y := 0 else if y > 22 then y := 22;
    pencolor (none);  moveto (x * 7, ymax - (y + 1) * 8)
  end;

  procedure wr (p : string;  x, y : integer);
  { writes the prompt p at the logical text position (x, y), unless the
    prompt is null, in which case the screen is cleared from lines x through
    y. }
  var i, j : integer;
  begin
    if length (p) > 0 then begin wrxy (x, y);  wstring (p) end
    else
      for i := 0 to y - x do begin
        wrxy (0, x + i);  for j := 1 to 30 do wchar (' ')
      end
  end;
  procedure wrst (p : string;  x, y : integer);
  var i : integer;
  begin
    wr (p, x, y);  for i := length (p) + x to 29 do wchar (' ')
  end;

  procedure rd (p : string;  x, y : integer;  var s : string);
  { writes the prompt p at the logical text position (x, y), then
    reads, character-by-character (echoing), and returns s }
  const bs = 8;  can = 24;
  var c : char;
      pn : integer;
      t : string [1];
      stop : Boolean;
  begin
    wr (p, x, y);  pn := length (p);  s := '';  t := ' ';
    repeat
      read (keyboard, c);
      stop := eoln (keyboard);
      if not stop then begin
        case ord (c) of
          bs : if pn > length (p) then begin
                 pn := pn - 1;  wr (' ', pn, y);
                 delete (s, length (s), 1)
               end;
          can : begin
                  wr ('', y, y);  wr (p, x, y);  pn := length (p);  s := ''
                end
        end;
        if (pn < 40) and not (ord (c) in [bs, can]) then begin
          t [1] := c;  s := concat (s, t);  wr (t, pn, y);  pn := pn + 1
        end
      end;
    until stop
  end;
```

Listing 1 continued on page 430

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Listing 1 continued:

```
function rdc (p : string;  x, y : integer) : char;
var c : char;
begin
  wr (p, x, y);  read (keyboard, c);  rdc := c
end;

procedure clrdisp;
begin
  wr ('', 0, 3)
end;

procedure boxlines (angle : ortho; x, y, n, p, LineLength : integer);
{ Draw n + 1 lines at the angle specified, p pixels apart }
var i : integer; {index}
begin
  if angle = horizontal then turnto (0) else turnto (90);
  for i := 1 to n do begin
    pencolor (none);  moveto (x, y);
    pencolor (white); move (LineLength);
    if angle = horizontal then y := y + p else x := x + p
  end { for }
end; { boxlines }

procedure Drawcharbox (x, y : integer);
{ This draws the exploded character box (the "pallet") onto the screen }
begin { Drawcharbox }
  boxlines (horizontal, x, y, 9, 9, 63); {9 horizontal lines 9 pixels apart}
  boxlines (vertical, x, y, 8, 9, 72);    {8 vertical lines 9 pixels apart}
end; { Drawcharbox }
function keysense : Boolean;
{ Tell me when the user has pressed a key with the Sup-R-Term board }
const clear = -16368; {location to clear keyboard strobe}
      kbd = -16384;   {location of keyboard input byte}

  function peek (addr : integer) : integer;
  type word = packed array [0..1] of 0..255;
       trix = record
                case Boolean of
                  false: (ptr: ^word);  {pointer to a Pascal word}
                   true: (int: integer) {its representation}
              end;
  var magic : trix;
  begin
    magic.int := addr;         {set up the pointer}
    peek := magic.ptr^ [0]     {look at what the pointer illuminates}
  end;

begin {keysense}
  keysense := peek (kbd) > 128;  {data come in as negative ASCII}
end;

function upcase (c : char) : char;
{ Translate the character to upper case }
begin
  if c in ['a'..'z'] then upcase := chr (ord (c) - ord ('a') + ord ('A'))
  else upcase := c
end;

function gc (legal : legalset; prompt : string; echo : Boolean) : char;
{ Read a character from the keyboard until it is legal }
var c : char;
    s : string [1];
begin
  s := ' ';
  repeat
    if echo then c := rdc (prompt, 0, 0) else read (keyboard, c);
    c := upcase (c);
  until c in legal;
  gc := c
end;

procedure nextchar (x, y : integer);
{ Causes the turtle to move to logical text position (x, y).  Top left
 corner is (0, 0).  }
begin {nextchar}
  pencolor (none);
  if x < 0 then x := 0 else if x > 22 then x := 22;  {set x min and max}
  if y < 0 then y := 0 else if y > 13 then y := 13;  {set y min and max}
  moveto (x * xblocksize, ymax - (y + 1) * yblocksize + 1)
end; {nextchar}

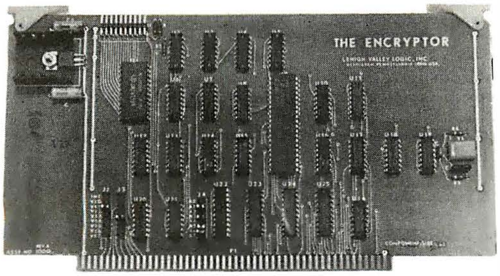
procedure onbox (c : char);
{ put the turtle at the logical "box" of the character specified }
begin
  nextchar (ord (c) mod CharsPerRow + 3, TopRow + ord (c) div CharsPerRow)
end;

procedure stepchar (c : char);
{ Move the turtle to the next character to be edited }
begin
  onbox (c);  turnto (0);  move (2);  turnto (90);  move (2);
end;

procedure drawallchars;
```

Listing 1 continued on page 432

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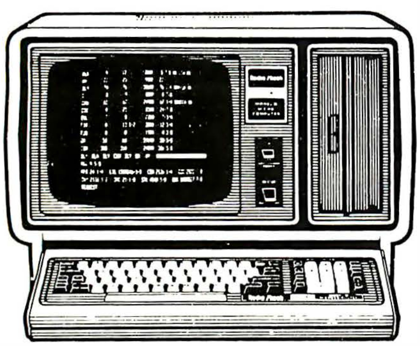
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Listing 1 continued:

```
{ Crank out the characters in the charset file in a nice format }
var c : char;
    line : integer;

  procedure stepback (ic : integer);
  { Moves the turtle to the specified character and back one pixel }
  begin
    onbox (chr (ic));  turnto (-90);  move (1);  turnto (180);  move (1)
  end;

begin {drawallchars}
  {reset did an initial 'get' for us}
  for c := chr (0) to chr (127) do begin
    stepchar (c);
    drawblock (icfile^ [ord (c)], 1, 0, 0, 7, 8, turtlex, turtley, 10)
  end;
  close (icfile);    {keep it kosher}
  stepback ((CharRows - 1) * CharsPerRow); {go to the bottom line}
  boxlines (horizontal, turtlex, turtley, CharRows + 1, yblocksize,
            CharsPerRow * xblocksize);
  stepback ((CharRows - 1) * CharsPerRow); {put the turtle back}
  boxlines (vertical, turtlex, turtley, CharsPerRow + 1, xblocksize,
            CharRows * yblocksize)
end;

procedure Genchar;
{ This procedure does the actual editing }
type cursor = (pallet, menu);
var c : char;          {the character for edit}
    x, y : integer;    {cursor position}
    bitbox : block;  {edit box}
    inc : char;        {input character}
    stack : array [0..7] of block;  {bitbox stack for saving characters}
    sp, ts : integer;   {stack pointers}

  procedure clearbits;
  { Initialize the edit parameters }
  var i, j : integer;
  begin
    x := 0;   y := 0;
    for i := 0 to 7 do for j := 0 to 7 do bitbox [i, j] := 0
  end;

  procedure placechar (c : char);
  { Put the character in the bitbox where it's supposed to go }
  begin {placechar}
    stepchar (c);
    drawblock (bitbox, 2, 0, 0, 7, 8, turtlex, turtley, 10);
  end;  {placechar}

  procedure putblock (which : color;  x, y : integer);
  { Put a block of the specified color both on the edit screen and
    on the current edit character's corresponding position.  This also
    changes the contents of bitbox }
  begin
    if (x in [0..6]) and (y in [0..7]) then begin
       drawblock (filler [which], 1, 0, 0, 8, 8,
                  xboxcorner + (x * 9) + 1, yboxcorner + (y * 9) + 1, 10);
       drawblock (filler [which], 1, 0, 0, 1, 1,
                  turtlex + x, turtley + y, 10);
       bitbox [y, x] := ord (which)
    end
  end;

  procedure newchar;
  { Finish the edit }
begin
  placechar (c);  {draw the character as it will appear}
  exit (Genchar)
end;

procedure clearchar;
{ Clear the current character }
var i, j : integer;
begin
  clearbits;  {reinitialize}
  for i := 0 to 6 do for j := 0 to 7 do putblock (fblack, i, j)
end;

procedure spraychar (c : char);
{ Put the specified character onto the pallet }
var i, j : integer;
begin
  stepchar (c);
  for i := 0 to 6 do for j := 0 to 7 do
    if screenbit (turtlex + i, turtley + j) then putblock (fwhite, i, j)
    else putblock (fblack, i, j)
end;

procedure flashit (where : cursor;  x, y : integer);
{ flash the cursor at the current edit position }
var k : Boolean;
```

Listing 1 continued on page 434

Listing 1 continued:

```
procedure delay (var k : Boolean);
{ insert a delay between flashes }
var i : integer;
begin
  i := 100;
  while (not k) and (i > 0) do begin i := i - 1;  k := keysense end;
end;

procedure dopallet;
var original : onebit;
    origscr : Boolean;

  procedure putdot (on : Boolean;  x, y : integer);
  { also flash the corresponding pixel in the edit character }
  var fcolor : color;
  begin
    if on then fcolor := fwhite else fcolor := fblack;
    drawblock (filler [fcolor], 1, 0, 0, 1, 1,
               turtlex + x, turtley + y, 10)
  end;

begin {dopallet}
  original := bitbox [y, x];
  origscr := screenbit (turtlex + x, turtley + y);
  while not k do begin
    putblock (fwhite, x, y); putdot (true, x, y);  delay (k);
    putblock (fblack, x, y); putdot (false, x, y); delay (k)
  end;
  if original = 1 then putblock (fwhite, x, y)
  else putblock (fblack, x, y);
  putdot (origscr, x, y)
end;

procedure domenu;
var reversed : Boolean;

  procedure xor;
  begin
    drawblock (filler [fwhite], 2 * ((xblocksize + 15) div 16), 0, 0,
               xblocksize, yblocksize - 1, turtlex, turtley, 6)
    end;

  begin {domenu}
    onbox (chr (y * CharsPerRow + x));
    reversed := false;
    while not k do begin
      xor;  delay (k);  reversed := not reversed;
    end;
    if reversed then xor
  end;

begin  {flashit}
  k := false;
  case where of
    pallet : dopallet;
      menu : domenu
  end; {case}
end;

procedure push;
{ save the current bitbox on the stack }
begin
  stack [sp] := bitbox;
  sp := (sp + 1) mod 8
end;

procedure pop;
{ restore the bitbox from the top of stack }
begin
  sp := sp - 1;  if sp = -1 then sp := 7;
  bitbox := stack [sp];
  stepchar (c);
  drawblock (bitbox, 2, 0, 0, 7, 8, turtlex, turtley, 10);
  spraychar (c)
end;

procedure shift;
{ shift the character up, down, left, or right }
var x, y : integer;

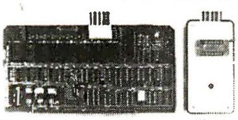
  procedure shiftup;
  begin
    for y := 7 downto 1 do for x := 0 to 6 do
        bitbox [y, x] := bitbox [y - 1, x];
    for x := 0 to 6 do bitbox [0, x] := 0
  end;

  procedure shiftdown;
  begin
    for y := 0 to 6 do for x := 0 to 6 do
        bitbox [y, x] := bitbox [y + 1, x];
    for x := 0 to 6 do bitbox [7, x] := 0
  end;
```

Listing 1 continued on page 436

Circle 378 on inquiry card.

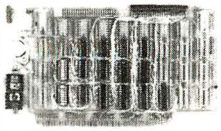
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Circle 164 on inquiry card.

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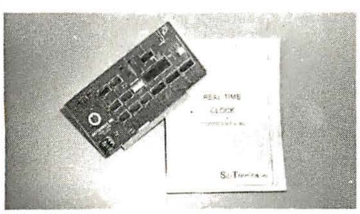
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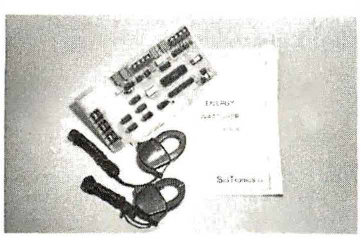
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Circle 371 on inquiry card.

Listing 1 continued:

```
procedure shiftleft;
begin
  for x := 0 to 5 do for y := 0 to 7 do
      bitbox [y, x] := bitbox [y, x + 1];
  for y  := 0 to 7 do bitbox [y, 6] := 0
end;

procedure shiftright;
begin
  for x := 6 downto 1 do for y := 0 to 7 do
    bitbox [y, x] := bitbox [y, x - 1];
    for y := 0 to 7 do bitbox [y, 0] := 0
  end;

begin {shift}
  wrst ('Shift character', 0, 4);
  case gc (['U', 'D', 'L', 'R', '2', '4', '6', '8'], '', false) of
    'U', '8' : shiftup;
    'D', '2' : shiftdown;
    'L', '4' : shiftleft;
    'R', '6' : shiftright
  end; {case}
  placechar (c);  spraychar (c)
end;

procedure invert;
{ invert the entire character }
var x, y : integer;
begin
  for y := 0 to 7 do for x := 0 to 6 do
    bitbox [y, x] := 1 - bitbox [y, x];
  placechar (c);  spraychar (c)
end;

function select : char;
{ select a character for editing }
var comm : char;
begin
  clrdisp;
  wr ('''.'' accepts', 0, 0);
  wr ('Up,Down,Left,Right', 0, 1);
  repeat
    flashit (menu, selx, sely);
    read (keyboard, comm);
    case upcase (comm) of
      'U', '8' : if sely - 1 in [0..CharRows - 1] then sely := sely - 1;
      'D', '2' : if sely + 1 in [0..CharRows - 1] then sely := sely + 1;
      'L', '4' : if selx - 1 in [0..CharsPerRow - 1] then selx := selx - 1;
      'R', '6' : if selx + 1 in [0..CharsPerRow - 1] then selx := selx + 1;
      '.', '5' : begin
                   select := chr (sely * CharsPerRow + selx);
                   exit (select)
                 end
    end; {case}
  until HellFreezesOver
end;

procedure getchar;
{ Duplicate another character for editing }
var sc : char;
begin
  wrst ('Get character', 0, 4);
  sc := select;      {select the character}
  push;              {push the old character}
  spraychar (sc);    {put the new character onto the pallet}
  placechar (c)      {put it into the edit position}
end;

procedure PromptState;
begin
  wrst ('Edit character', 0, 4);
  stepchar (c)
end;

procedure PromptEdit;
begin
  clrdisp;

    wr ('New,Clear,Pop,Invert,Get', 0, 0);
    wr ('[Shift] Up,Down,Left,Right', 0, 1);
    wr ('''.'' (set),'' '' (clear)', 0, 2);
    PromptState
  end;

  procedure setup;
  begin
    clearbits;  sp := 0;
    spraychar (c);             {put the selected character onto the pallet}
    for ts := 0 to 7 do push;  {fill stack with original character}
    PromptEdit
  end;

begin { Genchar }
  wrst ('Select character for edit', 0, 4);
  c := select; {select character for edit}
```

Listing 1 continued on page 438

Circle 420 on inquiry card.

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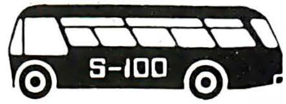
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Circle 90 on inquiry card.

Listing 1 continued:

```
    setup;        {set up the pallet}
    repeat
      flashit (pallet, x, y); {flash the cursor at the current position}
      read (keyboard, inc);   {read the character just typed}
      case upcase (inc) of    {convert to upper case and select action}
             'N' : newchar;                                  {accept and exit}
             'C' : begin push; clearchar end;                {clear pallet}
        'U', '8' : if y + 1 in [0..7] then y := y + 1;       {move cursor up}
        'D', '2' : if y - 1 in [0..7] then y := y - 1;       {move cursor down}
        'L', '4' : if x - 1 in [0..6] then x := x - 1;       {move cursor left}
        'R', '6' : if x + 1 in [0..6] then x := x + 1;       {move cursor right}
             'P' : pop;                                      {pop char from stack}
             'S' : begin shift; PromptState end;             {shift char}
             'I' : invert;                                   {invert char}
             'G' : begin getchar; PromptEdit end;            {retrieve another char}
        '.', '5' : putblock (fwhite, x, y);                  {white space}
        ' ', '0' : putblock (fblack, x, y)                   {black space}
      end; {case}
    until HellFreezesOver
  end; { Genchar }

  procedure gather;
  { get all the edited characters into their output configurations }
  const msg = 'writing out';
  var i, x, y : integer;
      cval : charimage;
      bitshift : array [0..6] of integer;
      dotcount : integer;

    procedure writedot (i : integer);
    begin
      if i mod CharsPerRow = 0 then begin
         wr ('.', length (msg) + dotcount, 0);
         dotcount := dotcount + 1
      end
    end;

  begin
    wr ('', 0, 3);  wr (msg, 0, 0);
    bitshift [0] := 1;   bitshift [1] := 2;
    bitshift [2] := 4;   bitshift [3] := 8;
    bitshift [4] := 16;  bitshift [5] := 32;
    bitshift [6] := 64;  dotcount := 0;
    for i := 0 to 127 do begin
      stepchar (chr (i));
      for y := 0 to 7 do begin
        cval [y] := 0;
        for x := 0 to 6 do
          if screenbit (turtlex + x, turtley + y) then
             cval [y] := cval [y] + bitshift [x];
      end; {for}
      cfile^ [i] := cval;
      writedot (i)
    end {for}
  end;

  procedure getfiles;
  { Get input and output file names and open them }
  var sysio : integer;
  begin
    repeat
      wr ('', 0, 0);  rd ('Input file: ', 0, 0, filename);
      if length (filename) = 0 then exit (program);
      {$I-}  reset (icfile, filename);  {$I+}
      sysio := ioresult;
      if sysio <> 0 then wr (concat ('?Cannot open ', filename), 0, 1);
    until sysio = 0;
    repeat
      wr ('', 1, 1);  rd ('Output file: ', 0, 1, filename);
      if length (filename) = 0 then exit (program);
      {$I-} rewrite (cfile, filename); {$I+}
      sysio := ioresult;
      if sysio <> 0 then wr (concat ('?Cannot open ', filename), 0, 2);
    until sysio = 0;
  end;

  procedure initialize;
  begin
    Initturtle;
    fillscreen (black);
    fillchar (filler [fwhite], sizeof (cblock), 255);
    fillchar (filler [fblack], sizeof (cblock), 0);
    getfiles;  fillscreen (black);
    drawcharbox (xboxcorner, yboxcorner);  drawallchars;
    selx := 0;  sely := 0;  {initialize character selection coordinates}
  end;

  procedure shutdown;
  { Get the edited characters and output the charset file }
  begin
    gather;
    put (cfile);
    close (cfile, lock);
    clrdisp;  wr (concat ('[', filename, ' made]'), 0, 1);
    if gc (['Y', 'N'], 'new edit? ', true) = 'N' then exit (program);
```

Listing 1 continued on page 440

Listing 1 continued:

```
    initialize
  end;

  procedure abort;
  begin
    clrdisp;
    if gc (['Y', 'N'], 'Abort: are you sure? ', true) = 'Y' then exit (program)
  end;

begin { MakeGraphicChars }
  initialize;
  repeat
    clrdisp;  wrst ('Character Editor', 0, 4);
    case gc (['A', 'Q', 'M'], 'Abort, Quit, Make character: ', true) of
      'A' : abort;     {terminate with no save}
      'Q' : shutdown;  {terminate with save}
      'M' : Genchar    {make new character}
    end; { case }
  until HellFreezesOver
end.
```

Text continued from page 426:

move the cursor about within the menu. In the first method, you type the letters U, D, L, and R (for up, down, left, and right, respectively). In the second method, you use a standard numeric keypad (not normally present on the Apple) by pressing the number corresponding to the direction of desired cursor movement (i.e., 2 = down, 4 = left, 6 = right, 8 = up). When the cursor is placed over the character that you wish to edit, press the period key or 5. The character is displayed on the editing pallet and the list of edit options appears.

Character Editing

A new cursor appears in the lower left-hand corner of the editing pallet. As with character selection, the cursor is moved about within the pallet with the letters U, D, L, and R, or with the digits on the keypad. The latter method is somewhat easier to use. However, if your Apple is like mine, you will have to suffer use of the directional mnemonics.

In order to make a white block, the period key or 5 is pressed. To make a black block, the space bar or 0 is pressed. If you are observant, you may have noticed by now that all cursor movement and flashing are duplicated by a one-pixel cursor within the menu box of the selected character. In fact, any action taken in the pallet is duplicated to scale within the selected character.

But there is more to it than that. Typing C clears the pallet, giving you

Prompt	Options
ABORT,QUIT,MAKE CHARACTER:	A = abort; do not save editing done Q = quit; save editing done M = select and edit a character
'.' ACCEPTS UP,DOWN,LEFT,RIGHT	"." (or 5) = select character U (or 8) = move cursor up D (or 2) = move cursor down L (or 4) = move cursor left R (or 6) = move cursor right
NEW,CLEAR,POP,INVERT,GET [Shift] UP,DOWN,LEFT,RIGHT '.' (SET), ' ' (CLEAR)	N = new character; terminate edit C = clear pallet P = pop character from stack I = invert pallet G = get and copy alternate character S = shift character (up, down, left, right) U (or 8) = move cursor up D (or 2) = move cursor down L (or 4) = move cursor left R (or 6) = move cursor right "." (or 5) = set current pixel " " (or 0) = clear current pixel

Table 1: *A summary of commands for the CHEDIT program.*

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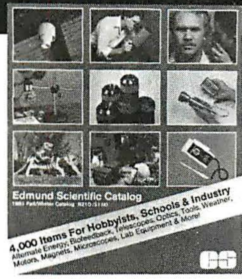
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the proverbial clean slate. If you have done this by accident, don't panic; the character is not lost forever. While in edit mode (as opposed to initial character selection mode), the character is saved in an 8-level circular stack. To recover the original character, type P (for pop). Upon entry to edit mode, the stack is filled with the original character found. Therefore, subsequent pops will only yield the same character. However, no mechanism yet exists for recovering from an accidental pop. Thus, this should be used as a "restart edit" command, rather than as a method of comparing or saving succeeding edits. Commands that "push" characters onto the stack are Clear (C) and Get (G). The number of pushes is finite; only the eight most recently cleared characters are saved.

If you wish to obtain another character for editing that might be similar in form or dimension to the one you have in mind, the Get command copies a specified character into the character currently under consideration. As previously mentioned, this operation performs a push of the old character. To perform a Get, typing G places you into a character-selection mode that is used in the same way as the initial selection. The letters U, D, L, and R are used to move the cursor about within the menu; the period is used to select the character under the cursor. A copy of the character specified then appears in the pallet and within the menu box of the character currently being edited.

A Shift mode allows you to move a character about within the pallet. Although pixels shifted off the edges of the pallet are lost and cannot be recovered, the entire original character may be recovered with the pop command mentioned earlier. To shift the character, press S followed by the direction of the shift (U, D, L, or R). Since only one shift is performed, subsequent shifts require S to be pressed again before specifying the direction.

Finally, an Invert command causes all black pixels to become white and vice versa. This is done by pressing I.

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Pressing I twice in a row yields the original character. The drawback to use of this command is that shifting causes black pixels to be brought in on one edge of the pallet. If you want a white background, these pixels must be filled in separately. The alternative is to make the background black before shifting, then change the background back to white with the Invert command.

Terminating the Edit

Once you are satisfied with an edit, type N (for new character). This makes the change permanent. The ABORT, QUIT, MAKE CHARACTER prompt is then displayed and a new character may be selected for edit, or the new characters may be saved in the output file with the Q command. Then you are asked whether you want to begin a new edit session. Typing N terminates the program. Typing Y causes prompts for new input and output files to appear. If a null (Return key only) is entered for either file name, the program is terminated.

Using the New Character Set

In order to *use* a character set that you create, you must rename the file output from CHEDIT to SYSTEM.CHARSET. This is required by the TURTLEGRAPHICS unit.

The alternative is to write your own versions of WCHAR, WSTRING, and CHARTYPE by using DRAWBLOCK, in which case you must match some of the declarations made in CHEDIT (*charimage*, *charset*, and *charfile*), and read in the character-set file of your own choosing (see procedure *drawallchars*).

Summary

CHEDIT is a simple editor for Apple-format character sets. If required, modifications should be easy to make. I graciously forgive Apple for providing such a limited form of graphics support with its Pascal package; it *is* adequate for many small applications. But with CHEDIT, there is no reason why you should be restricted only to the character sets provided by Apple. ■

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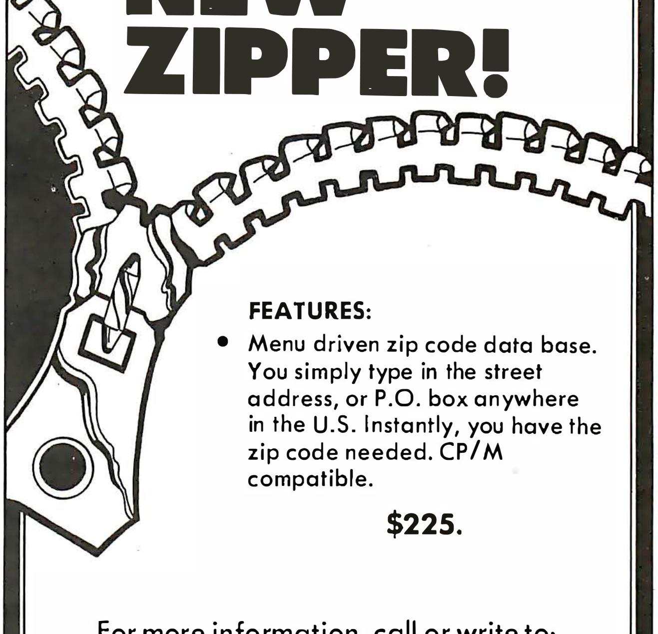
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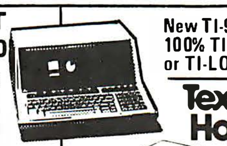
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Give Your Apple a Voice

A Speech-Development System Using the Radio Shack Speech Synthesizer

John Blankenship
Professor of Computer Technology
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"Speech. It separates man from the lower forms of life and from mere machines." In the not-too-distant past, this statement would have been true. Now, with many consumer products gaining the power of speech, it seems only natural that the complete home-computer system have the power of verbal communication.

I added the power of speech to my Apple II with the aid of a Radio Shack Voice Synthesizer. To make the same conversion with your Apple you will need to tinker with its hardware: if you own a TRS-80 you will have to modify some of the software presented here, and if you own anything else you will have to do a little of both. I will attempt to cover the subject in such a manner that modifications will be as painless as possible. They might even be fun!

Speech Alternatives

I had wanted to add the power of speech to my computer for some time and had explored several alternatives. I found that the best speech quality resulted from methods that *reproduced*, rather than *created*, the human sounds desired.

A simple sampling method that uses an A/D (analog-to-digital) converter can produce superb sound quality if the sample rate is sufficiently high. Each sample, however, uses 1 byte of memory, so it is not unreasonable for one second of speech to require 4000 bytes. In addition, the vocabulary is fixed and considerable effort is required to increase it.

Another method for reproducing speech is LPC (linear predictive coding). This technique is used in Texas Instruments' Speak & Spell, and while it reduces the memory requirement to several hundred bytes per second, the quality of speech is slightly reduced (and it still has the disadvantage of a fixed vocabulary).

The Radio Shack Speech Synthesizer generates the sounds that make up speech, called phonemes, through the use of Votrax circuitry. The Speech Synthesizer can generate 45 different sounds, 10 of which are capable of varying durations (see samples in table 1). The major advantage of this method is that the words are not reproduced, but *created* from a single-byte code, which translates to less than 20 bytes for each second of output. These phonemes can be combined in any order, thus permitting an essentially unlimited vocabulary.

Phoneme Sound	Example Usage	ASCII Characters
"a"	day	)
"ah"	honest	;
"aw"	law	1
"e"	meet	E
"eh"	heavy	3
"oo"	book	%
"u"	school	U

Table 1: *Examples from among the 45 phonemes available with Radio Shack's Speech Synthesizer. These sounds can be combined to form words and sentences.*

In the past I had heard speech that was generated from phonemes, and it was generally of poor quality. After a great deal of practice, I discovered that quality was more a function of the programmer than of the hardware. One major consideration in understanding speech is the rhythm. As an example, pronounce the word "kick." You will notice a pause before the last "k." The *word flow* can be improved through the insertion of such pauses.

Even the phonemes themselves can present problems. Let's examine the word "name." When asked what sounds form this word, most people initially respond with "n", "a", "m", where the "a" is long. If these sounds were sent to the synthesizer it would say something that *resembled* "name," but it would hardly sound proper.

A closer examination of the word "name" reveals the sounds "n", "a", "e", "m", where both the "a" and "e" are long. When these sounds are re-

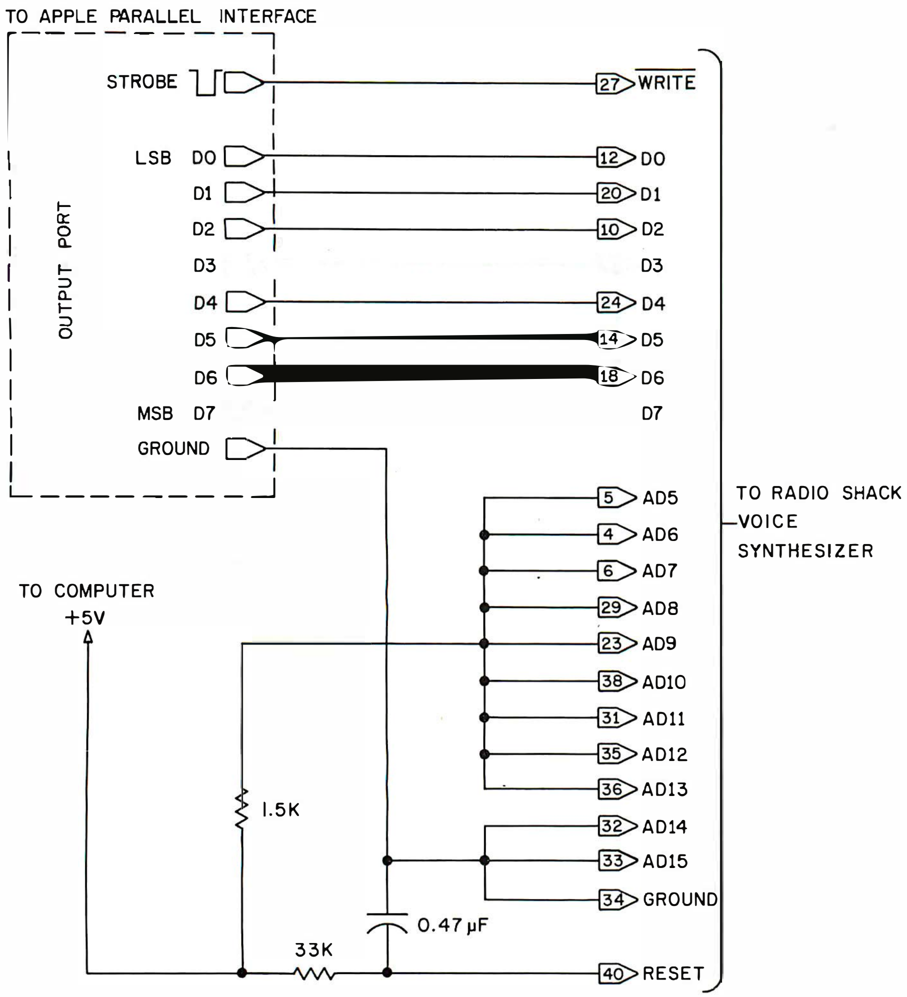


Figure 1: *Schematic diagram for the interface between the Apple II Parallel Interface card and the Radio Shack Speech Synthesizer.*

produced by the synthesizer, the word is easily recongnized. Now, however, the word ends too abruptly. The addition of another "m" to form the combination "n", "a", "e", "m", "m" sounds nearly human. (By lengthening the "a" or the "e" sound you can attain a pronunciation applicable to a particular region of the country.)

Word flow can also be improved by the addition of such neutral phonemes has "eh" and "uh." The transition between sounds in the word "name" is improved by adding an "uh" between the "n" and the "a" sounds.

By varying these techniques, I convinced myself that above-average speech quality could be achieved with phonemes. In order to manipulate the sounds quickly and easily, I decided to write a program that could perform the following:

- Aid in determining the proper sounds
- Keep those sounds in a dictionary
- Convert words to sounds automatically

I wanted to write the program in a modular format for two reasons. First, although the program would be written on an Apple II, I expected that many Radio Shack TRS-80 owners would want to convert it. The use of small modules, each with specific functions, would simplify the modification process considerably.

Second, although this program would be used to develop a dictionary, it would also be used in an application program to decode and output the words. If I wrote the original program in modules, the sections not required in the application program could be deleted to conserve memory.

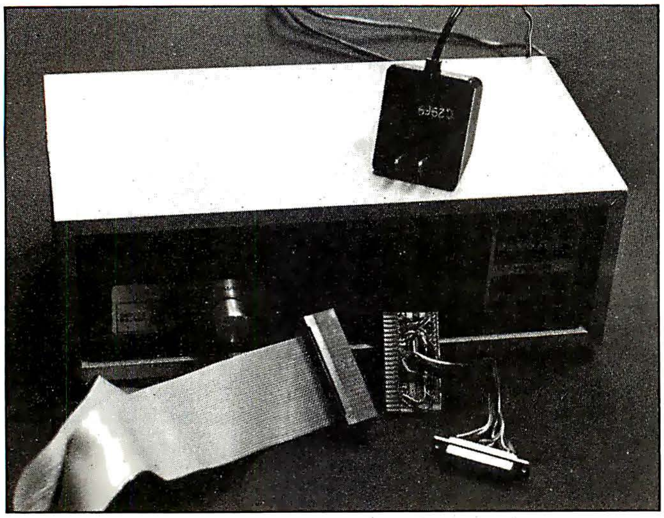


Photo 1: *The Radio Shack Speech Synthesizer with the author's adapter for the Apple II computer.*

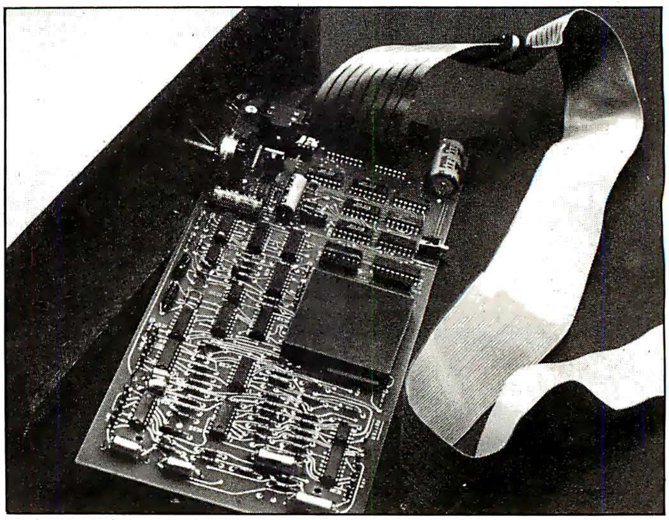


Photo 2: *Inside the Speech Synthesizer. The Votrax circuitry is encased in plastic, and none of the supporting integrated circuits have markings.*

Let's take a closer look at the Radio Shack Voice Synthesizer to determine the requirements of such a program.

What the Synthesizer Needs

The synthesizer (see photo 1) has a built-in amplifier and speaker, and the ribbon cable plugs directly into the TRS-80 keyboard or expansion connector. It uses memory-mapped I/O (input/output) so that anything stored in the last 32 screen memory locations is sent to the synthesizer.

In order to use this system with my Apple II computer, I made an adapter (also shown in photo 1) to connect it to my parallel interface card, which doubles as my printer interface when the system is not speaking. The only unusual requirement of the adapter is that the memory-mapped port inside the synthesizer must be hardwired to an address that will keep it enabled. I also added a power-on reset so that I would not have to contend with random sound each time the unit was turned on. Figure 1 shows the schematic for the adapter.

It is difficult to identify any of the internal circuitry of the synthesizer. The Votrax unit is completely sealed, and none of the surrounding integrated circuits are marked (see photo 2). But the central component, the Votrax SC-01 integrated circuit, is available to experimenters from the Micromint, 917 Midway, Woodmere, NY 11598, (516) 374-6793.

Listing 1: *Simple Apple program to convert sentences into phoneme codes. This routine uses information stored in DATA statements and performs a linear search to produce the proper output. The relatively slow speed limits it to use with vocabularies of less than 100 words.*

```
10    INPUT T$
15    GOSUB 60000
20    GOTO 10
30    END
60000 T1$ = "":OUT = 49361
60005  FOR T = 1 TO  LEN (T$)
60007 T1$ = T1$ +  MID$ (T$,T,1)
60010  IF  MID$ (T$,T,1) = " " THEN 60050
60020  NEXT T
60030  RETURN
60050  RESTORE
60055  READ T2$,T3$: IF T1$ <  > T2$ + " " THEN 60055
60057 T3$ = T3$ + " "
60060  FOR T1 = 1 TO  LEN (T3$)
60070  POKE OUT, ASC ( MID$ (T3$,T1,1))
60071  PRINT  MID$ (T3$,T1,1);
60080  POKE (OUT + 3),0
60090  NEXT T1
60095 T1$ = "": GOTO 60020
60100  DATA  YOU,Y<<U
60101  DATA  WILL,WW#!I##LL0
60102  DATA  NOT,"NNA;A8TT0"
60103  DATA  LIE,"0LAA;A*0"
60104  DATA  TO,TTH<UUU0
60105  DATA  ME,MME.&0
```

Software

Actual operation of the unit is easy. Listing 1 shows a simple program that converts entered sentences to phoneme codes and sends the codes to the synthesizer.

The words and their respective sounds are kept in data statements. I soon found that the major disadvantage of this method was loss of speed. After I acquired several hundred words in my dictionary, the time that elapsed between words spoken became several seconds; this is obviously excessive for real-time output. However, the small program works well for vocabularies of less than 100 words, and it is very easy to add to an application program.

In addition to the speed problem of those applications that require large vocabularies, I still needed to develop the proper sounds. The program in listing 2, which fulfills all of the requirements set forth earlier, is the result of my effort. Let's examine each module in this program individually.

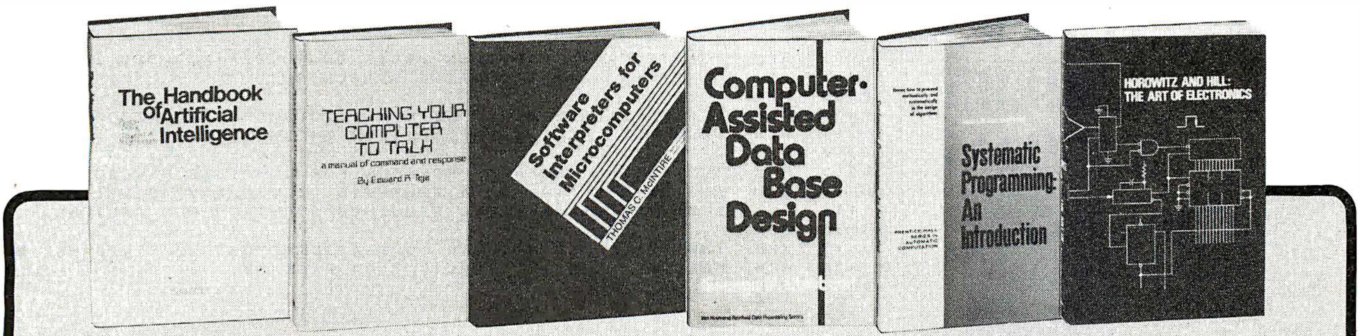
The first section provides the basic documentation. Note that all variables start with the letter T. In general, variable names should be easily identifiable, but I chose to modify this policy. Since this program would be added to other programs, I wanted to avoid using the same variable in both.

Text continued on page 454

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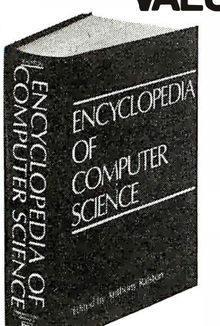
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Listing 2: *Completed speech-development program for the Apple. This program incorporates features that help determine proper sounds, maintain a dictionary, and automatically convert entered words to sounds.*

```
60000  REM ********************
60001  REM *     SPEECH       *
60002  REM *   DEVELOPEMENT   *
60003  REM *     SYSTEM       *
60004  REM *       BY         *
60005  REM * JOHN BLANKENSHIP *
60006  REM ********************
60007  REM  THIS PROGRAM HAS BEEN DESIGNED TO BE INCLUDED INTO ANY
60008  REM  OTHER PROGRAM REQUIRING SPEECH OUTPUT
60009  REM
60010  REM  ALL VARIABLES BEGIN WITH 'T' TO HELP PREVENT CONFLICTS
60011  REM  WHEN WRITING THE APPLICATION PROGRAM
60012  REM
60013  REM  THE ENTIRE PACKAGE PROVIDES FOR COMPLETE DEVELOPMENT
60014  REM  AND MAINTENANCE OF A PHONETIC DICTIONARY AS WELL AS THE
60015  REM  SOFTWARE TO MAKE THE REQUIRED RUN TIME CONVERSIONS
60016  REM
60017  REM  THE SYSTEM IS MODULAR SO THAT UNNEEDED ROUTINES MAY BE
60018  REM  DELETED FROM THE APPLICATION PACKAGE
60019  REM


60020  REM ********************
60021  REM *   INITIALIZATION *
60022  REM ********************
60023  DIM TW$(300),TP$(300)
60024  LET D$ =  CHR$ (4)
60025  REM


60026  REM ********************
60027  REM *       MENU       *
60028  REM ********************
60029  TEXT : HOME
60030  PRINT "         SPEECH DEVELOPEMENT SYSTEM"
60031  PRINT "         WRITTEN BY JOHN BLANKENSHIP": VTAB 8
60032  PRINT "      1. INPUT DATA FROM DISK"
60033  PRINT "      2. SAVE DATA TO DISK"
60034  PRINT "      3. PREPARE NEW WORD FOR ENTRY"
60035  PRINT "      4. SAY A SENTENCE"
60036  PRINT "      5. LIST DICTIONARY"
60037  PRINT "      6. RETURN TO BASIC"
60038  VTAB (20): PRINT "WHICH? ";: GET TT$
60039  IF  VAL (TT$) = 6 THEN  HOME : END
60040  LET T1 =  VAL (TT$): IF T1 < 1 OR T1 > 5 THEN  PRINT  CHR$ (
7): GOTO 60038
60041  ON T1 GOTO 60043,60082,60081,60137,60122
60042  REM


60043  REM ********************
60044  REM *    INPUT DATA    *
60045  REM *     FROM DISK    *
60046  REM ********************
60047  HOME
60048  PRINT "         INPUT DATA FROM DISK": VTAB 8
60049  INPUT "WHAT FILE NAME ";TN$
60050  IF  LEN (TN$) = 0 THEN 60026
60051  PRINT D$"OPEN SPEECH."TN$

60052  PRINT D$"READ SPEECH."TN$
60053  INPUT TA
60054  VTAB 20: PRINT "FILE ";: INVERSE : PRINT TN$;: NORMAL : PRIN
T " CONTAINS "TA" WORDS "
60055  FOR T1 = 1 TO TA
60056  INPUT TW$(T1)
60057  INPUT TP$(T1)
60058  NEXT T1
60059  PRINT D$"CLOSE SPEECH."TN$
60060  GOTO 60026
60061  REM


60062  REM *********************
60063  REM * SAVE DATA TO DISK *
60064  REM *********************
60065  HOME : PRINT "           SAVE DATA TO DISK": VTAB 8
60066  IF  LEN (TN$) = 0 THEN 60069
60067  PRINT "USE FILE NAME ";: INVERSE : PRINT TN$;: NORMAL : PRIN
T "? (Y/N) ": GET TT$
60068  IF TT$ = "Y" THEN 60070
60069  VTAB 12: INPUT "WHAT FILE NAME ";TN$
60070  VTAB 20: PRINT "SAVING "TA" WORDS"
60071  PRINT D$"OPEN SPEECH."TN$
```

Listing 2 continued on page 452

Listing 2 continued:

```
60072  PRINT D$"WRITE SPEECH."TN$
60073  PRINT TA
60074  FOR T1 = 1 TO TA
60075  PRINT TW$(T1)
60076  PRINT TP$(T1)
60077  NEXT T1
60078  PRINT D$"CLOSE SPEECH."TN$
60079  GOTO 60026
60080  REM


60081  REM ********************
60082  REM * PREPARE NEW WORD *
60083  REM ********************
60084  HOME : PRINT " PREPARE AND ADD NEW WORD TO DICTIONARY"
60085  LET T3 =  FRE (0)
60086  VTAB 4: INVERSE : PRINT "INSTRUCTIONS": NORMAL
60087  PRINT "      1. ENTER PHONETIC SOUND"
60088  PRINT "      2. HIT RETURN TO HEAR IT"
60089  PRINT "      3. CONTINUE THE PROCESS UNTIL              CORRE
CT"
60090  PRINT "      4. HIT RETURN (NO ENTRY) TO SAVE"
60091  PRINT
60092  PRINT "     NOTE:A SPACE AT THE END OF A WORD             IS
REQUIRED TO STOP SOUND"
60093  POKE 34,12: REM  SET TOP OF WINDOW
60094  LET TS$ = ""
60095  REM  INPUT LINE WITH EDITING TO MEMORY STARTING AT 512 - THE
N CONVERT TO STRING
60096  POKE 51,160: CALL 64874
60097  LET TS$ = "": FOR T1 = 1 TO 255: IF  PEEK (511 + T1) = 141 T
HEN 60099
60098  LET TS$ = TS$ +  CHR$ ( PEEK (511 + T1) - 128): NEXT T1
60099  IF  LEN (TS$) = 0 THEN 60103
60100  LET T1$ = TS$
60101  LET T$ = TS$: GOSUB 60186
60102  GOTO 60094
60103  IF  RIGHT$ (T1$,1) = " " AND T1$ < > " " THEN T1$ =  LEFT$
(T1$, LEN (T1$) - 1): GOTO 60103
60104  PRINT "DO YOU WISH TO SAVE THE SOUND": INVERSE : PRINT T1$;:
 NORMAL : PRINT " (Y/N) ";: GET TT$: PRINT
60105  IF TT$ < > "Y" THEN  TEXT : GOTO 60026
60106  INPUT "WHAT WORD HAS THIS SOUND ";TT$
60107  IF  LEN (TT$) = 0 THEN 60026
60108  REM  FIND ALPHABETICAL POSITION OF NEW WORD IN ARRAY
60109  IF TA = 0 THEN 60118
60110  FOR T1 = 1 TO TA
60111  IF TW$(T1) < TT$ THEN  NEXT T1
60112  IF TW$(T1) < > TT$ THEN 60115
60113  LET TP$(T1) = T1$
60114  TEXT : GOTO 60081
60115  LET T2 = T1
60116  REM  MOVE ARRAY TO MAKE ROOM FOR NEW WORD
60117  FOR T1 = TA TO T2 STEP  - 1:TW$(T1 + 1) = TW$(T1):TP$(T1 + 1
) = TP$(T1): NEXT T1
60118  LET TA = TA + 1
60119  IF T2 = 0 THEN T2 = 1
60120  LET TW$(T2) = TT$:TP$(T2) = T1$
60121  TEXT : GOTO 60081: REM


60122  REM ********************
60123  REM *  LIST DICTIONARY *
60124  REM ********************
60125  HOME : PRINT "            LIST DICTIONARY": VTAB 3: PRINT "(A
NY KEY TO CONTINUE - ESC FOR MENUE)": VTAB 10
60126  IF TA = 0 THEN  PRINT "NO WORDS IN DICTIONARY": FOR T3 = 1 T
O 1000: NEXT T3: GOTO 60026
60127  PRINT "DO YOU WANT THE PRINTER ON (Y/N) ";: GET T$
60128  IF T$ = "Y" THEN  CALL 768: REM  TURN PRINTER ON
60129  HOME :T3 = 1: FOR T2 = 1 TO TA
60130  LET T3 = T3 + 1: IF T$ < > "Y" AND T3 = 20 THEN  GET T1$:T3
 = 1: IF T1$ =  CHR$ (27) THEN 60026
60131  PRINT TW$(T2),TP$(T2)
60132  NEXT T2
60133  IF T$ < > "Y" THEN  GET T1$
60134  PRINT D$"PR#0": REM  TURN PRINTER OFF
60135  GOTO 60026
60136  REM


60137  REM ********************
60138  REM *  SAY A SENTENCE  *
60139  REM ********************
60140  HOME : PRINT "             SAY A SENTENCE"
60141  PRINT : PRINT "DO YOU WANT GRAPHICS (Y/N) ";: GET TS$
60142  LET TG = 0:TF = 0: IF TS$ = "Y" THEN TG = 1
60143  PRINT
60144  POKE 34,5: VTAB 6: REM  SET WINDOW
60145  PRINT "WHAT SENTENCE ": INPUT TS$
60146  IF  LEN (TS$) = 0 THEN 60026
60147  GOSUB 60150: IF TG = 1 THEN  TEXT : GOTO 60137
60148  GOTO 60145
60149  REM
60150  REM ********************
60151  REM *     SAY TS$      *
60152  REM ********************
```

Listing 2 continued:

```
60153  IF TG = 0 THEN 60155
60154  IF TF = 0 THEN  GOSUB 60192:TF = 1
60155  LET TS$ = TS$ + " ":T1$ = "":T3 =  FRE (0)
60156  FOR T1 = 1 TO  LEN (TS$)
60157  IF  MID$ (TS$,T1,1) = " " THEN 60161
60158  LET T1$ = T1$ +  MID$ (TS$,T1,1)
60159  NEXT T1
60160  RETURN
60161  REM  BINARY SEARCH OF ARRAY FOR WORD
60162  IF  LEN (T1$) = 0 THEN 60159
60163  LET TL% = TA:TS% = 1
60164  LET T2$ = TW$(TS%):TT$ = TW$(TL%)
60165  IF T1$ > T2$ AND T1$ < TT$ THEN 60168
60166  IF T1$ = T2$ THEN T = TS%: GOTO 60176
60167  IF T1$ = TT$ THEN T = TL%: GOTO 60176
60188  LET T% = ((TL% - TS%) / 2) + TS%
60169  LET TY$ = TW$(T%)
60170  REM  NOT FOUND - SEND ORIGINAL WORD
60171  IF TY$ = T$ THEN T$ = T1$:T1$ = "": GOSUB 60181: GOTO 60159
80172  LET T$ = TY$
60173  IF T1$ > TY$ THEN 60175
80174  LET TL% = T%:TT$ = TY$: GOTO 60164
60175  LET TS% = T%:T2$ = TY$: GOTO 60164
60176  REM  FOUND AT ELEMENT T
60177  REM  FOUND AT T - SEND PHONETIC EQUIVALENT
60178  LET T$ = TP$(T): GOSUB 60181
60179  LET T1$ = "": GOTO 60159
60180  REM


60181  REM *********************
60182  REM *   OUTPUT  T$      *
60183  REM *  TO SYNTHESIZER   *
60184  REM *********************
60185  LET T$ = T$ + " ": IF TG THEN  GOSUB 60226: IF  RND (1) > .7
 THEN  GOSUB 60214
60186  FOR T3 = 1 TO  LEN (T$)
60187  POKE 49361, ASC ( MID$ (T$,T3,1)): POKE 49384,0: REM  SEND T
O OUTPUT PORT
60188  NEXT T3
60189  IF TG THEN  GOSUB 60234
60190  RETURN
60191  REM


60192  REM *********************
60193  REM *  DRAW LORES FACE  *
60194  REM *********************
80195  REM  MAIN FACE
60196  GR : POKE  - 16302,0: REM  FULL SCREEN GRAPHICS
60197  FOR T2 = 40 TO 47: HLIN 0,39 AT T2: NEXT T2
60198  COLOR= 8: HLIN 9,30 AT 0: COLOR= 7
60199  FOR T2 = 1 TO 39: HLIN 9,30 AT T2: NEXT T2
60200  VLIN 2,37 AT 8: VLIN 2,37 AT 31
60201  VLIN 4,35 AT 7: VLIN 4,35 AT 32
60202  VLIN 8,33 AT 6: VLIN 8,33 AT 33
60203  VLIN 13,32 AT 5: VLIN 13,32 AT 34
60204  VLIN 18,26 AT 4: VLIN 18,26 AT 35
60205  HLIN 9,30 AT 40: HLIN 10,29 AT 41
60206  HLIN 10,29 AT 42: HLIN 11,28 AT 43
60207  HLIN 12,27 AT 44: HLIN 13,26 AT 45
60208  HLIN 14,25 AT 46: HLIN 15,24 AT 47
60209  REM  FACIAL FEATURES
60210  COLOR= 10: VLIN 23,33 AT 19: VLIN 23,33 AT 20
60211  COLOR= 3: VLIN 30,32 AT 18: VLIN 30,32 AT 21
60212  COLOR= 8: PLOT 18,33: PLOT 21,33
60213  HLIN 10,15 AT 16: HLIN 24,29 AT 16: GOSUB 60234
60214  REM  EYES
60215  COLOR= 7: FOR T4 = 19 TO 21
60216  HLIN 11,14 AT T4: HLIN 25,28 AT T4: NEXT T4
60217  LET TH% =  RND (1) * 5:TV% =  RND (1) * 2: COLOR= 0
60218  FOR T4 = 10 TO 11: FOR T5 = 19 TO 20
60219  PLOT T4 + TH%,T5 + TV%: PLOT T4 + 14 + TH%,T5 + TV%: NEXT T5
,T4
60220  COLOR= 3: HLIN 11,14 AT 18 + TV%: HLIN 25,28 AT 18 + TV%
60221  COLOR= 8: HLIN 10,15 AT 18: HLIN 24,29 AT 18
60222  HLIN 10,15 AT 22: HLIN 24,29 AT 22
60223  VLIN 19,21 AT 10: VLIN 19,21 AT 15
60224  VLIN 19,21 AT 24: VLIN 19,21 AT 29
60225  RETURN
60226  REM  MOUTH OPEN
60327  COLOR= 10: HLIN 16,23 AT 37: HLIN 17,22 AT 40
60228  COLOR= 8: PLOT 14,37: PLOT 25,37
60229  COLOR= 3: PLOT 13,36: PLOT 26,36
60230  COLOR= 0: HLIN 15,24 AT 38
60231  HLIN 16,17 AT 39: HLIN 22,23 AT 39
60232  COLOR= 8: HLIN 18,21 AT 39
60233  RETURN
60234  REM  MOUTH CLOSE
60235  COLOR= 7: HLIN 15,24 AT 39: HLIN 15,24 AT 40
60236  COLOR= 10: HLIN 16,23 AT 37: HLIN 17,22 AT 39
60237  COLOR= 8: PLOT 14,37
60238  COLOR= 3: PLOT 13,36: PLOT 26,36
60239  COLOR= 0: HLIN 16,17 AT 38: HLIN 22,23 AT 38
60240  COLOR= 8: HLIN 18,21 AT 38
60241  RETURN
```

Text continued from page 448:

The INITIALIZATION section dimensions the WORD and PHONEME arrays to hold 300 entries each. This situation can be modified, of course, to suit your needs. In addition, the string variable D$ is initialized by setting it equal to control-D for use in disk operation of the Apple. (This step would be omitted for such computers as the TRS-80.)

The MENU section allows easy selection of the desired function when developing a vocabulary. The GET statement permits you to enter data from the keyboard without using the Return key.

The two DISK modules save and retrieve the two arrays that contain the vocabulary. Two variables are particularly important if you are converting this program for use on another computer. The number of words in the dictionary, and thus the number of entries in each array, is the first number in the disk file. It is read into the variable TA, and it controls the number of words that are subsequently read into each array. The variable TN$ holds the name of the disk file: this allows you to use several dictionaries. Dictionaries can also be loaded and saved to other disks when required.

The section for PREPARING A NEW WORD allows you to easily develop the proper sounds for a new dictionary entry.

Any character or group of characters will be "said" by the synthesizer when the Return key is hit. The last sound is continually voiced, so each word should be followed by a space. This "problem" is actually a design feature. When developing a word, you can listen to each sound by typing its character and hitting Return with no space. This feature is indispensable when comparing different phonemes.

When the word is finally correct, hit Return with no entry, and you will be asked if you wish to save that sound. If you do, you will also be asked to supply a word that demonstrates the sound. Both the word and its sound will be automatically entered into the dictionary in alphabetical order. The importance of this will become apparent in a moment.

If you convert this program to another BASIC, lines 60095 to 60098 could present problems. These lines utilize a subroutine in the Apple's monitor that enters characters into the buffer area. A simple INPUT TS$ could have been used, but my method allows you to enter such illegal characters as semicolons and quotes. In addition, it preserves all of the Apple editing features.

The LIST DICTIONARY allows you to dump all the present words and their sound codes to the screen (or a printer). The listing scrolls a new screen full each time a key is pressed. ESC will abort the listing and return to the MENU.

The section SAY A SENTENCE is used to say the words contained in T$. It may be used as a separate subroutine if it is entered at line 60150, which only *says* TS$, without entering it from the keyboard. This module performs a binary search of the words in the dictionary and outputs the appropriate sound to the synthesizer.

By using a binary search of the dictionary, conversion is done very quickly. For example, 256 words can be examined with only eight reads. This is possible because the words are organized in alphabetical order and the program divides the remaining words in half with each successive guess.

If the word is not found in the dictionary, it (not its phonemes) is sent to the synthesizer. Such words are, at best, poorly pronounced, but at least the system does not crash in the middle of a big demonstration. In most cases you'll find that one bad word is easily recognized in the context of a complete sentence.

The FRE(0) function in lines 60085 and 60155 forces an internal clean-up of the Applesoft string variables. This operation can require several seconds, depending on the length of the dictionary. When utilizing subroutines from this system in other programs, FRE(0) can be postponed until several sentences have been voiced. This will allow pauses at the most natural points.

Section OUTPUT T$ sends the phoneme code of each individual

word to the synthesizer. My program sends it to a port at address 49361 and strobes it in by writing to address 49364. On a TRS-80 you would only need to print T$ into the last 32 screen locations. The example programs provided in the synthesizer manual should aid in converting this module for use with a TRS-80.

One peculiarity of operating the system should be mentioned. Sending a "?" to the synthesizer will toggle it on or off depending on its present state. Since Reset does not turn the synthesizer on, you may or may not have to send a "?" to initially activate it.

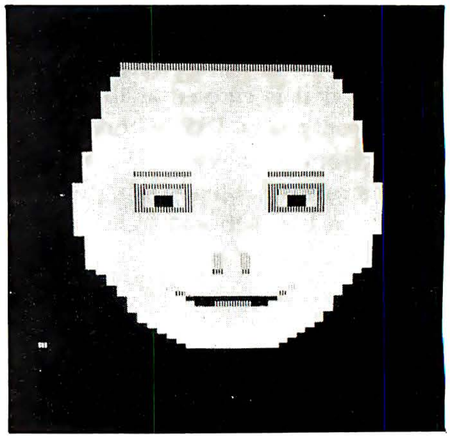


Photo 3: *Low-resolution graphics display adds life to the speech program.*

As an afterthought, I decided to add a little spice to the program. The final module (draw a low-resolution face) produces the graphics shown in photo 3. Such an addition would have to be greatly modified if run on a TRS-80, but I heartily recommend it. The mouth opens and closes with each word and the eyes (complete with eyelids) move at random. I can't tell you the reaction a talking face gets from a person not used to working with computers.

I'm extremely happy with the addition of voice output to my personal computer, and it has inspired several applications that may be discussed in future articles. If you want *your* machine to talk, compare the phonetics approach with other methods. If it meets your requirements, I hope that my speech-development system will make your life easier. ■

Hierarchical Interrupts

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Most popular microprocessors will support daisy-chained peripheral devices. These allow a peripheral close to the processor to gain priority over a more distant peripheral when both devices request interrupt service simultaneously. This is normally done by using two lines between the processor and its set of peripheral devices (see figure 1). The first line is the IRQ (interrupt-request line). Any device is allowed to "pull" this line to ground, thus generating a request for interrupt service. At the convenience of the processor, the second line (the interrupt-acknowledge line or INTACK) is energized, indicating that the processor is ready to accept an interrupt.

The INTACK line goes sequentially from device to device, thus giving rise to the term "daisy chain." If a device isn't requesting an interrupt, it passes the unchanged INTACK signal to its successor in the chain. If, however, a device is in the active state and is requesting an interrupt, it "traps" the acknowledge signal. Since devices farther down the line never receive the acknowledge signal, they don't take control of the processor or the system bus.

In any imaginable interrupt system, if devices A and B request interrupts simultaneously, either A wins or B wins (ties are not permitted). We have, in effect, a strict ordering of all the peripheral devices by priority. Adding a hierarchical level mechanism merely gives the device at level *n* priority over the devices on level $n-1$ or lower. In this sense, a daisy chain is a general solution to the problem of resolving simultaneous requests.

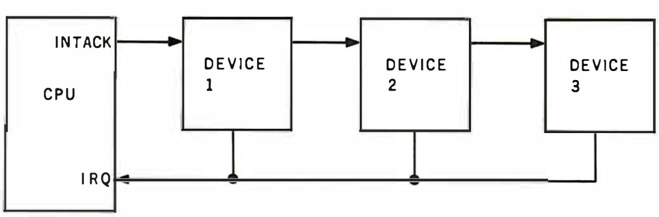


Figure 1: *Daisy-chain connection of interrupting peripherals. If two peripheral devices interrupt simultaneously, the device closer to the computer takes priority over the one farther away. This system allows a higher-priority device to interrupt a lower-priority device.*

Unlike a daisy chain, a hierarchical scheme keeps low-priority devices from interrupting the code processing the interrupt of a high-priority device. In a typical hierarchical scheme, the processor has a level at which it is currently running. Each peripheral device requests an interrupt on one of several lines: IRQ0, IRQ1 . . . IRQ*n* where *n* is commonly 3 or 7 (see figure 2). A priority encoder examines these request lines and outputs a binary number corresponding to the number of the highest active request line. This binary number is compared with the processor's current level and, if the level of the processor is greater than or equal to the level of the request, the request is not acted upon and no new interrupt is generated. Only if the request level exceeds the processor level will the current program be interrupted. If an interrupt is to be honored, the interrupt-acknowledge line (INTACK0, INTACK1 . . . INTACK*n*) corresponding to the level of the highest request is activated.

Three difficulties accompany the hierarchical-interrupt scheme. Foremost is the fact that many otherwise attractive microprocessors don't have one. Second, microprocessors that *do* incorporate such a scheme usually have too many levels (causing some hardware to go unused) or too few (almost as difficult as none at all). Third, for *n* levels, $2n$ lines must be added to the I/O (input/output) bus to convey requests and acknowledgments.

The Present Method

In a daisy chain, each peripheral device has an interrupt flag that has two states: on and off. To turn the processor's interrupt system back on (so that other, more important interrupts can be recognized), this initial interrupt flag must be cleared (thus releasing the IRQ line)

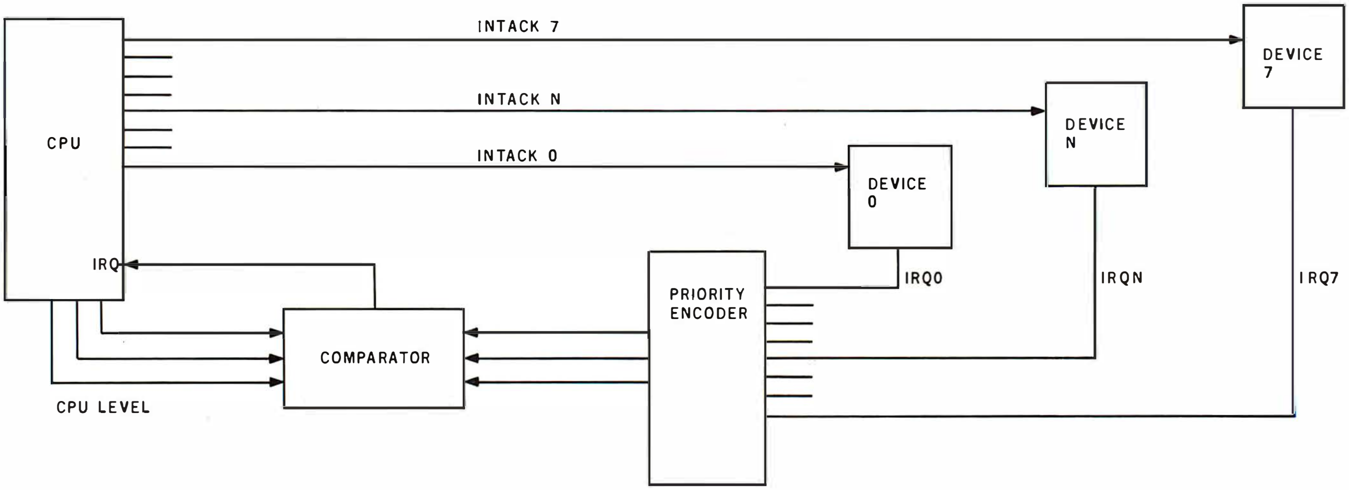


Figure 2: *A typical hierarchical-interrupt scheme. The processor keeps track of the interrupt level it's currently servicing and will pause to give service only if an interrupt occurs at a higher level.*

soon after its recognition. If this is not done and all interrupts are serviced with the interrupt system disabled, the intended hierarchy becomes a first-come-first-served system.

Peripheral devices could be equipped with a three-state interrupt flag:

Off—not requesting service (does not affect IRQ); passes INTACK down the chain (away from the processor) and passes IRQ up the chain (toward the processor).
On—requesting service (asserts IRQ); does not pass INTACK down line but traps it instead.
Blocking—not requesting service; does not pass IRQ up the chain.

States Off and On correspond to the two conventional states. In the Blocking state, the device refuses to allow lower-priority devices (those farther down the chain) to break into its interrupt-service routine, thus protecting its own priority and incidentally providing a hierarchy with as many levels as there are peripheral devices. When a device needs service, it changes from Off to On. At the first clear-interrupt flag (issued by the processor prior to reenabling the interrupt system), the device changes its state from On to Blocking. This releases the IRQ line and also prevents lower-priority devices from pulling it down. At the second clear-interrupt flag (issued by the processor at the end of the interrupt routine), the device changes from Blocking to Off.

Clearly a paragon of interrupt systems, it allows each device to protect its own service routine from all lesser requests. The system allows infinitely fine discrimination, with classes of devices having one member each.

A Less Expensive Realization

The system described above requires an additional flip-flop and a few additional gates at each peripheral device. If this configuration is too expensive, it's possible to envision an intermediate system.

Into the daisy chain we insert a few *blocking nodes* (see figure 3). To the processor, these look like normal peripheral devices with a peripheral address. They are capable of executing two operations: Block and Unblock. In the Unblock state these special nodes are transparent and have no effect on the daisy chain, but in the Block state they inhibit any interrupt requests from devices beyond them in the chain.

After recognizing an interrupt and before reenabling the interrupt system, the processor issues a Block command to the node just inboard of the active peripheral. At the conclusion of the service routine, the processor Unblocks the node and allows all peripheral devices an opportunity to compete for attention.

If the processor had one more output line (the Unblock line), we could dispense with the addresses for these nodes. On interrupt request, the nearest inboard node could set itself automatically to the Block state and forward the interrupt request to the processor. At the conclusion of an interrupt-service routine, the processor could issue an Unblock command on the Unblock line, and the Blocked node nearest the processor could reset itself.

Conclusion

Either of these solutions would provide a moderate-cost, reasonably flexible means of keeping low-priority devices from interrupting high-priority service routines. To be sure, the priority of a device would depend on its position in the daisy chain. Not only would it be a considerable nuisance to rearrange the priorities, but it would, in fact, be impossible to accomplish without operator assistance.

Using memory-mapped I/O with PIAs (peripheral interface adapters) or VIAs (versatile interface adapters) is a more flexible solution than either proposed here,

Number	Type	+5 V	GND
IC1	7402	14	7
IC2	7430	14	7
IC3	7474	14	7

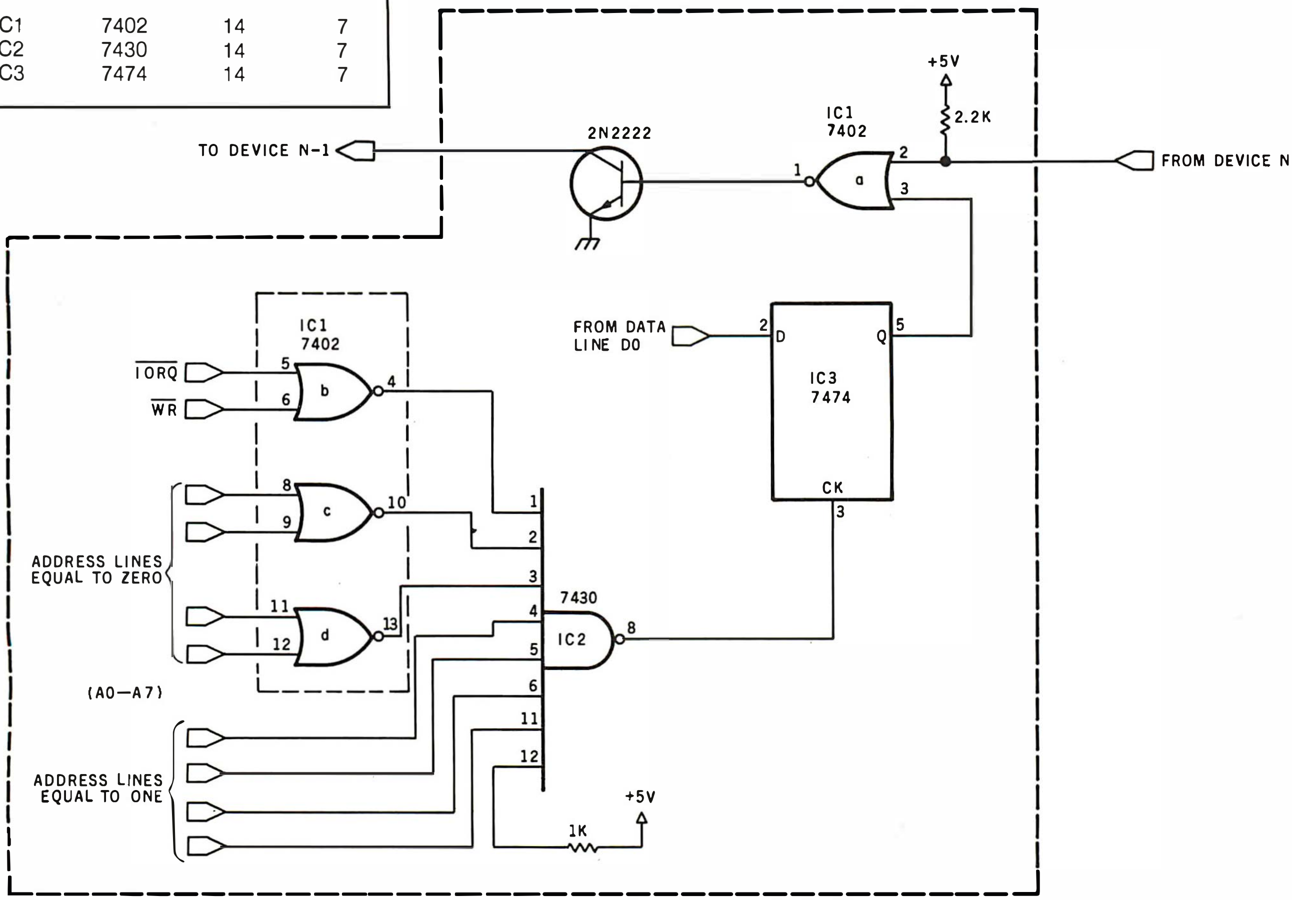


Figure 3: *A compromise hierarchical system. This method reduces cost by using "blocking nodes" in a daisy-chain system.*

because an arbitrary priority hierarchy can be constructed that doesn't even need to be transitive (A can block B and C, B can block C, and C can block A and B). The mask bits in the VIA permit and block interrupts from devices in any fashion that seems acceptable to the system at a particular time. For a system organized on an I/O bus, however, either of the schemes proposed here offers a great improvement over the simple interrupt armed or interrupt disarmed that have been the usual implementations to date. ■

Books Received

Apple II/III Software Directory, G. Van Diver and R. Love. Overland Park, KS: Vital Information Inc. (7899 Mastin Dr.), 1982; 1148 pages, 13 by 20.5 cm, softcover, ISBN none, $19.95.

Assembly Language for the PDP-11, Charles Kapps and Robert L. Starford. Boston, MA: CBI Publishing Company, 1981; 353 pages, 17.5 by 23.5 cm, hardcover, ISBN 0-87150-304-2, $23.50.

BASIC Programs for Home Financial Management, W. B. Goldsmith Jr. Englewood Cliffs, NJ: Prentice-Hall, 1981; 314 pages, 21.5 by 28 cm, hardcover, ISBN 0-13-066522-3, $18.95.

BASIC Programs for Scientists and Engineers, Alan R. Miller. Berkeley, CA: Sybex, 1981; 318 pages, 17.5 by 23.5 cm, softcover, ISBN 0-89588-073-3, $14.95.

A Bibliography of Computer Music, Sandra L. Tjepkema. Iowa City, IA: University of Iowa Press, 1981; 276 pages, 15 by 23 cm, hardcover, ISBN 0-87745-110-9, $17.50.

CAI Sourcebook, Robert L. Burke. Englewood Cliffs, NJ: Prentice-Hall, 1982; 206 pages, 15 by 23 cm, hardcover, ISBN 0-13-110155-2, $14.95.

Computers for People, Jerry Willis and Merl Miller. Beaverton, OR: Dilithium Press, 1982; 200 pages, 13 by 21 cm, softcover, ISBN 0-918398-64-9, $7.95.

Computer Simulation of Classical Substitution Cryptographic Systems, Rudolph F. Lauer. Laguna Hills, CA: Aegean Park Press, 1981; 111 pages, 21.2 by 27.2 cm, softcover, ISBN 0-89412-050-6, $24.80.

Database Management System Anatomy, James A. Larson. Lexington, MA: Lexington Books, 1982; 183 pages, 15.5 by 22.5 cm, hardcover, ISBN 0-669-04544-6, $22.95.

Databook of Venture Capital Sources for High-Technology Companies, Richard Loftin. Washington, DC: Financial Data Corporation, 1981; 576 pages, 14.5 by 22.3 cm, softcover, ISBN 0-940758-00-8, $115.

The 8085/SDK-85 [Hands-On, Volume 2], Howard Boyet. New York: MTI Publications, 1981; 814 pages, 15.5 by 23 cm, softcover, ISBN none, $19.95.

The 8051: Programming, Interfacing, Applications, Howard Boyet and Ron Katz. New York: MTI Publications, 1982; 396 pages, 17 by 25.2 cm, softcover, ISBN none, $19.95.

Experiments in Electronics, Instrumentation, and Microcomputers, F. Holler, J. Avery, S. Crouch, and C. Enke. Menlo Park, CA: The Benjamin/Cummings Publishing Co., 1982; 326 pages, 21.2 by 27.2 cm, softcover, ISBN 0-8053-6918-X, $13.95.

From Chips to Systems: An Introduction to Microprocessors, Rodnay Zaks. Berkeley, CA: Sybex, 1982; 552 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8988-063-6, $14.95.

H-8 Programming for Beginners, Ron Santore, Don

Inman, and Bob Albrecht. Portland, OR: Dilithium Press, 1980; 195 pages, 13 by 20.5 cm, softcover, ISBN 0-918398-17-7, $8.95.

Information Systems Development, A Systematic Approach, Mats Lundeberg, Göran Goldkuhl, and Anders Nilsson. Englewood Cliffs, NJ: Prentice-Hall, 1981; 337 pages, 17.5 by 23.5 cm, hardcover, ISBN 0-13-464677-0, $24.95.

Introduction to Interactive Computer Graphics, Joan E. Scott. New York: John Wiley & Sons, 1982; 255 pages, 14.6 by 22.3 cm, hardcover, ISBN 0-471-05773-8, $24.95.

Introduction to Real-Time Software Design, S. T. Allworth. New York: Springer-Verlag, 1981; 140 pages, 14.6 by 22.3 cm, softcover, ISBN 0-387-91175-8, $14.

Inventory Management for Small Computers, Chuck Atkinson. Beaverton, OR: Dilithium Press, 1982; 194 pages, 13 by 20.5 cm, softcover, ISBN 0-918398-48-7, $16.95.

Minds and Mechanisms, Margaret A. Boden. Ithaca, NY: Cornell University Press, 1981; 311 pages, 13.5 by 22 cm, hardcover, ISBN 0-8014-1431-8, $29.50.

Oh! Pascal!, Doug Cooper and Michael Clancy. New York: W. W. Norton & Company, 1982; 476 pages, 17.5 by 23.5 cm, softcover, ISBN 0-393-95205-3, $15.95.

Pascal: A Problem Solving Approach, Elliot B. Koffman. Reading, MA: Addison-Wesley, 1982; 470 pages, 15.5 by 22.5 cm, softcover, ISBN 0-201-10341-9, $14.95.

PET Fun and Games, Ron Jeffries and Glen Fisher. Berkeley, CA: Osborne/McGraw-Hill, 1981; 192 pages, 21.2 by 27.2 cm, softcover, ISBN 0-931988-70-5 $10.

Practical Data Base Management, edited by the Auerbach Publishers Staff. Reston, VA: Reston Publishing Company, 1981; 430 pages, 14.6 by 22.3 cm, hardcover, ISBN 0-8359-5591-5, $24.95

Robot Manipulators, Mathematics, Programming, and Control, Richard P. Paul. Cambridge, MA: The MIT Press, 1981; 279 pages, 15 by 23 cm, hardcover, ISBN 0-262-16082-X, $25.

Simple Pascal, James J. McGregor and Alan H. Watt. Rockville, MD: Computer Science Press, 1981; 182 pages, 15 by 22 cm, softcover, ISBN 0-914894-72-2, $10.95.

Strategic Financial Planning with Simulation, Dennis E. Grawoig and Charles L. Hubbard. Princeton, NJ: Petrocelli Books, 1982; 643 pages, 14.6 by 22.3 cm, hardcover, ISBN 0-89433-115-9, $35.

Trends in Information Processing Systems (Proceedings of the Third Conference of the European Cooperation in Informatics, Munich, October 20-23, 1981), volume in the Lecture Notes in Computer Science series, edited by G. Goos and J. Hartmanis. New York: Springer-Verlag, 1981; 349 pages, 16 by 23.8 cm, softcover, ISBN 3-540-10885-8, $20.

A User Guide to the Unix System, Jean Yates and Rebecca Thomas. Berkeley, CA: Osborne/McGraw-Hill, 1982; 496 pages, 7.4 by 9 cm, softcover, ISBN 0-931988-71-3, $15.99.

Writing Interactive Compilers and Interpreters, P. J. Brown. New York: John Wiley & Sons, 1981; 265 pages, 14.6 by 22.3 cm, softcover, ISBN 0-471-10072-2, $14.50. ■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

Hobbyists Compute Under the Big Sky

The Big Sky Micro-Computer Club currently has about 35 members. All types of computers are of interest to the club. Beginners and experts alike are invited to join and help with the newsletter. Contact the Big Sky Micro-Computer Club, POB 21456, Pioneer Station, Billings, MT 59102, or call Wes Henley at (406) 656-4013.

Personal Computer Group in Capital

IBMicro is a new group for IBM Personal Computer users in the Washington, DC, area. The club has created a charter and bylaws and is busily at work on a newsletter, a bulletin board, and hardware and software exchanges. The group plans to have monthly meetings with guests speakers and feedback from members. Special-interest groups for word processing, graphics, games, and other applications are planned. Contact IBMicro, 1414-C Wright Circle, Bolling AFB, Washington, DC 20336.

Nevada COBOL Users Group

The Nevada COBOL Users Group has been formed to distribute information on applications and routines written in the language. The club will provide coordination among users developing extensions to Nevada COBOL. Information will be distributed through periodic newsletters. Contact Bob Blum, Nevada COBOL Users Group, 5536 Colbert Trail, Norcross, GA 30092, (404) 449-8948.

Starter Kit Group

Cary Davids has started a users group for owners of the Z80 Starter Kit from SD Systems. The club produces a newsletter. Contact Cary Davids, 6000 Puffer Rd., Downers Grove, IL 60516.

Osborne Group Assembling

A new group for Osborne Computer users is being formed in the Tampa Bay area. For further details, contact Frederick Dunn, POB 517, Clearwater, FL 33517, (817) 446-7239.

South American Hobbyists

The Concepción Computer Club is interested in all areas of microcomputing. The club would appreciate information and newsletters from other users groups. A special edition of the group's newsletter, *Boletín del Concepción Computer Club*, is produced in English. Contact Raúl H. Figueroa Rebolledo, Concepción Computer Club, POB 685, Concepción, Chile, Tel: 24854.

6800/6809 Fans in Sweden

PD 68 is a group of Motorola 6800 and 6809 users in Sweden. The group meets on the last Thursday of each month, excluding June, July, and December, at ABF Huset, Hammarby Centrum, in Stockholm. The Flex operating system is of particular interest to group members, who number about 300. A newsletter, *MPU-laren*, is produced each quarter. The club would like to hear from the personal-computing community in the U.S. Contact Jason King, Ludwigsbergsgatan 13[1], S-117 26, Stockholm, Sweden, Tel: 08/68 23 11.

New Address

The new mailing address for the Amateur Computer Group of New Jersey (ACG-NJ) is POB 319, South Bound Brook, NJ 08880.

Explorer 85 Users Group

A new group is being formed for owners of Netronics' Explorer 85 system. The group plans to produce a free newsletter of hardware and software ideas. For more information, contact Gord Wiggins, POB 88, Cartwright, Newfoundland, A0K 1V0, Canada.

Graphics Club Forming

A computer graphics club is being formed in the Connecticut/Westchester County, New York area. Plans call for group meetings with manufacturers of graphics products and creating a newsletter. For further details, contact Howard Rothman, 218 Huntington Rd., Bridgeport, CT 06608, (203) 579-0472. ■

Software Received

Apple

AgDisk Financial Management Series One, an agricultural financial-management package in Pascal for the Apple II. Floppy disk, $140. Harris Technical Systems, 624 Peach St., POB 80837, Lincoln, NE 68501.

Alkemstone, an adventure-type game for the Apple II. Floppy disk, $39.95. Level-10, Suite 507, 7475 Dakin St., Denver, CO 80221.

Apple-Aids, a disk-utility package for the Apple II. Floppy disk, $49.95. Advanced Operating Systems, 450 St. John Rd., Michigan City, IN 46360.

Beer Run, an arcade-type game for the Apple II. Floppy disk, $29.95. Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.

Enhanced Graphics Software for the IDS 460G/560G, a graphics utility for the Apple II. Floppy disk, $44.95. Computer Station Inc., 11610 Page Service Dr., St. Louis, MO 63141.

Graphic Writer, utility to combine graphics with Applewriter text for the Apple II. Floppy disk, $34.95. Computer Station Inc. (see address above).

Hadron, an arcade-type game for the Apple II. Floppy disk, $34.95. Sirius Software Inc. (see address above).

Hi-Res Computer Golf, a computerized golf game for the Apple II. Floppy disk, $29.95. Avant-Garde Creations, POB 30160, Eugene, OR 97403.

The Liberator, a programming utility and library of subroutines for the Apple II. Floppy disk, $29.95. Pear Software, 407 Terrace, Ashland, OR 97520.

Pascal Hi-Res Graphics Dump Routine for the IDS 460G, a graphics utility in Pascal for the Apple II. Floppy disk, $44.95. Computer Station Inc. (see address above).

Snake Byte, an arcade-type game for the Apple II. Floppy disk $29.95. Sirius Software Inc. (see address above).

Sneakers, an arcade-type game for the Apple II. Floppy disk, $29.95. Sirius Software Inc. (see address above).

Ultra Hi-Res Graphics, utility for use with the IDS 460G/560G printers with the Apple II. Floppy disk, $49.95. Computer Station Inc. (see address above).

Atari

Atari Word Processor, a word-processing system for the Atari 800. Floppy disk, $149.95. Atari Inc., Computer Division, POB 427, Sunnyvale, CA 94086.

The Duplicating Machine, a program-duplication utility for the Atari 400 and 800. Floppy disk, $19.95. Midwest Software, 2707A Ridge Court, Lawrence, KS 66044.

CP/M

CP/M Adventures 1-12, a series of Scott Adams's adventures for CP/M (Z80). 8-inch floppy disk, $129.95. Adventure International, 507 East St., POB 3435, Longwood, FL 32750.

Ficomp CP/M 2.2. Utilities, a set of utility programs for CP/M (Z80). 8-inch floppy disk, $24.95. Ficomp Inc., 3017 Talking Rock Dr., Fairfax, VA 22031.

Copy86, a utility program for copying Z80 CP/M files to and from 86-DOS. 8-inch floppy disk, $120. GIOS Enterprises, 9784 Woodhollow Way, Sacramento, CA 95827.

PET

Concentration, Memory, Cosmic Collision, Hangman, and Torpedo Command, games for the PET 2001. Cassette, $5.99 each. Royal Software, 149-45 83rd St., Howard Beach, NY 11414.

PET/CBM Cross-Reference Program, a cross-reference utility program for the PET/CBM. Floppy disk, $29.95. Oppenheimer Software, 79th Street Boat Basin #39, New York, NY 10024.

Texas Instruments

Adventureland, an adventure-type game for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc., 13500 North Central Expressway, POB 225012, Dallas, TX 75265.

Car Wars, an arcade-type game for the TI-99/4. Command Module (i.e., ROM cartridge), $39.95. Texas Instruments Inc. (see address above).

The Count, an adventure-type game for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc. (see address above).

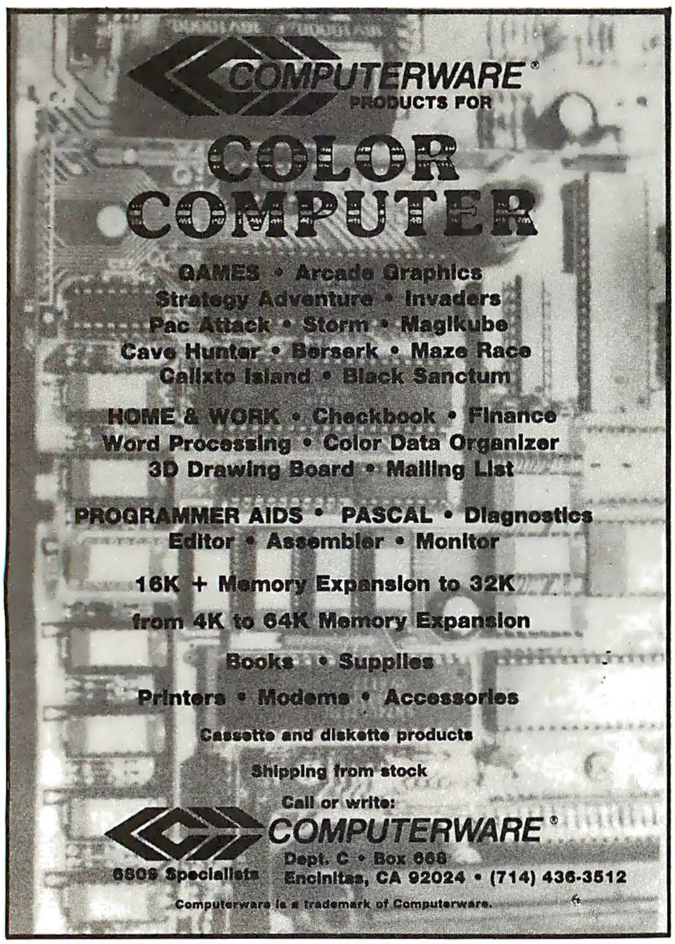
Ghost Town, an adventure-type game for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc. (see address above).

Pirate Adventure, an adventure-type game for the TI-99/4. Floppy disk and Command Module (i.e., ROM cartridge), $29.95. Texas Instruments Inc. (see address above).

Pyramid of Doom, an adventure-type game for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc. (see address above).

TRS-80

Bisplan, a business-modeling program for the TRS-80 Models I and III. Cassette, $20. Mariah Com-



Software Received

puting, POB 513, Columbia, MO 65205.

DOSfix, a set of modifications for TRSDOS for the TRS-80 Models II and III. Floppy disk, $15 (Model II) and $10 (Model III). Snapp-Ware, 3719 Mantell Ave., Cincinnati, OH 45236.

Macro-Mon, a machine-language utility program for the TRS-80 Models I and III. Cassette, $54.95; floppy disk, $59.95 (Model I) and $69.95 (Model III). Advanced Operating Systems, 450 St. John Rd., Michigan City, IN 46360.

Omniterm, a telecommunications software package for the TRS-80 Models I and III. Floppy disk, $95. Lindbergh Systems, 41 Fairhill Rd., Holden, MA 01520.

Rubik's Cube Coach, a simulator and solution for the Rubik's Cube puzzle for the TRS-80 Model I. Cassette, $14.95. H & S Computer Co., 1024 Alamosa Dr., Claremont, CA 91711.

Snapp-II, extended BASIC for the TRS-80 Models II and III. Floppy disk, $200 (Model II) and $125 (Model III). Snapp-Ware (see address above).

Snapp-III, language enhancements for the BASIC interpreter for the TRS-80 Models II and III. Floppy disk, $100 (Model II) and $75 (Model III). Snapp-Ware (see address above).

Snapp-IV, screen-management utilities for the TRS-80 Models II and III. Floppy disk, $100 (Model II) and $75 (Model III). Snapp-Ware (see address above).

Snapp-V, disk input/output file-management utilities for the TRS-80 Models II and III. Floppy disk, $75 (Model II) and $60 (Model III). Snapp-Ware (see address above).

Snapp-VI, a string space-management utility for the TRS-80 Models II and III. Floppy disk, $100 (Model II) and $75 (Model III). Snapp-Ware (see address above).

Snapp-VII, a reformatter for BASIC programs to increase readability for the TRS-80 Model III. Floppy disk, $40. Snapp-Ware (see address above).

Super Color Terminal, telecommunications software for the TRS-80 Color Computer. Cassette and floppy disk, $69.95. Nelson Software Systems, POB 19096, Minneapolis, MN 55419.

Time Quest, an adventure-type game for the TRS-80 Models I and III. Floppy disk, $24.95; cassette, $19.95. The Programmer's Guild, POB 66, Peterborough, NH 03458.

Other Computers

Adventure A, an adventure-type game for the Sinclair ZX80 and 81. Cassette, $19.95. Softsync, POB 480, Murray Hill Station, New York, NY 10156. ■

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Programming PERT in BASIC

A method for planning complex activities where no precedents exist.

Steven Zimmerman
College of Business
and Management Studies
University of South Alabama
Mobile, AL 36688

Leo M. Conrad
Imagineering Concepts
POB 9843
Mobile, AL 36691-0843

The Performance Evaluation and Review Technique (PERT) is a powerful method of planning complex activities, especially pioneering projects like the creation of a new business or the development of a new machine. The innovative nature of these projects assures that few precedents exist to help estimate performance time.

PERT gives managers the tools to deal with uncertainty; PERT is management in action. It plans, schedules, and controls activity. Using PERT, contractors, builders, engineers, and businessmen can improve planning in the midst of uncertainty and save money as a result.

Until now, only large businesses with access to large computers could use PERT. The program in listing 1 brings PERT's power to microcomputer users. (Our article "Programming the Critical-Path Method in BASIC" in the July 1982 issue of BYTE will present the Critical-Path Method, which places greater emphasis on the trade-off between the time and the costs required to complete a project.)

Before presenting our program, however, we'll give you a glimpse at PERT's history, briefly describe the nature of PERT analysis, suggest one possible PERT application for a manager, and examine the mathematics behind PERT.

The events that have zero slack time form the critical path.

Origins of PERT

PERT dates back to a team created by the Navy Special Projects Office, Lockheed Aircraft Corporation, and the management consulting firm of Booz, Allen, and Hamilton. Work during World War I on the Gannt scheduling chart and the Gannt milestone chart should also be noted because these precipitated the development of the network diagram (described later) used in PERT.

Managers of many different kinds of tasks have successfully applied PERT. One particularly spectacular result of the PERT approach is the Polaris missile, which also occasioned PERT's development. (Lockheed Aircraft was the major contractor for Polaris.) Completion time was critical in the Polaris program, but there was considerable uncertainty about how long the required activities would take. Moreover, the start of many activities depended on the completion of others. These are the chief reasons why PERT employs a network scheme and focuses on the probability of various activities finishing at specified times.

The Start of PERT Analysis

PERT analysis begins by reducing a project description to a list of events and activities. An activity is a part of a project that consumes resources or time and has a definable beginning and end. An event is a point in time, an instant. The beginning and ending points of an activity are events. To apply PERT to a complex project, you must identify all the events needed to complete the project and all the activities that result in the identified events.

As an example, we'll use a simplified version of an actual con-

Letter	Activity	Beginning Event	End Event
A	assemble accounting data	1	2
B	look for bank	1	3
C	look for real-estate agent	1	4
Z	seek permits	2	7
D	make market study of area	2	3
G	look for contractor	2	5
F	seek insurance for construction	2	6
H	get basic architectural plans	3	5
E	make cost study	3	4
I	buy land	4	5
J	list materials	5	6
K	get more detailed architectural plans	5	7
L	have survey made	5	8
M	buy first batch of materials	6	8
O	buy second batch of materials	6	9
N	complete detailed internal layout of foundation	7	8
Q	hire crew	7	9
P	build foundation	8	9

Table 1: *The activities required to build a foundation. The program in listing 1 uses the letters at left to identify the activities. The two columns at right list the first and last event during each activity. An event is the completion of one or more activities.*

struction project that we just completed. To simplify, we'll end our example with the completion of the building's foundation. We identified 18 activities needed to complete this foundation. Table 1 lists the activities, assigned letters A through Q and Z. Each of the nine events in the project consists of the completion of one or more activities.

The Bubble Diagram

The second stage in PERT analysis is the layout of a "bubble" diagram that shows how the necessary activities and events form a sequence of steps. Figure 1 is the bubble diagram of our foundation-building example. With or without PERT, specifying the sequence of a project's steps is obviously an important planning activity. Most contractors lay out the sequence of tasks in a project in some fashion, but PERT makes task sequencing a formal activity. Formalizing this process lends valuable structure to essential planning. In particular, making a bubble diagram forces the planner to specify which activities depend on the completion of others.

Diagrams like that shown in figure 1 are also called networks. A PERT network has one initial event, at the extreme left, and one terminal event, at the extreme right. The circles in figure 1 are numbered and represent events. The lines are lettered and represent activities; each line has an arrow indicating its direction in time from beginning to completion. The network as a whole shows the series of activities that must be performed to complete the project. The arrows show which activities and events logically precede others.

An event that results from completion of more than one activity is called a merge event; an event that represents the joint beginning of more than one activity is called a burst event. Before any activity can start, all preceding activities must be completed (but not all simultaneously). An arrow's length and its compass direction are insignificant.

Dashed lines in network diagrams represent "dummy" activities. A

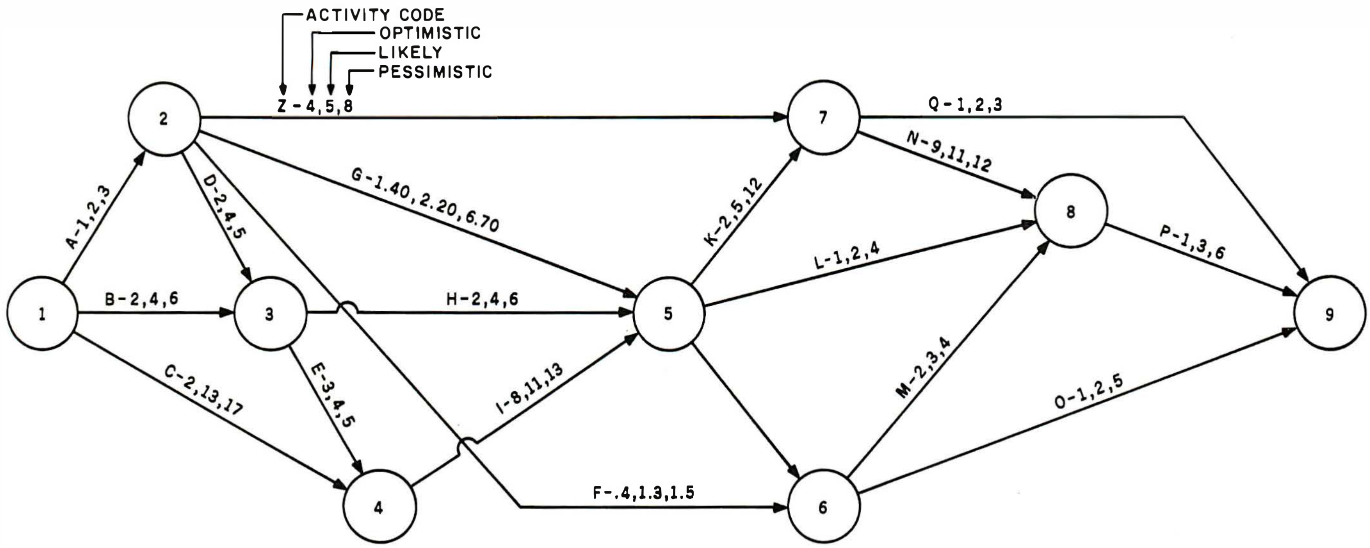


Figure 1: *The PERT network diagram of the activities required to build a foundation. Each circle represents an event and each line between circles represents one of the activities listed in table 1. The three numbers given for each activity represent human estimates of the optimistic (minimum), likely, and pessimistic (maximum) time in weeks that each activity will take. The network has one initial event, event 1 at the extreme left, and one terminal event, event 9 at the extreme right. The critical path is the one that takes the most time to get from event 1 to event 9.*

dummy activity exists when the completion of one event depends on the completion of another but requires no additional work or activity. PERT handles dummy activities like any others but assigns the activity zero time and zero costs.

The Critical Path

The longest route from the beginning of the network on the left to its end on the right determines the time required to complete the project. This line is the critical path, which determines the minimum time required to complete a job. Although the concept of a critical path may sound complex, it is simple once you've laid a project out in a bubble diagram.

Critical-path analysis can reveal ways to shorten the critical path and to control the total length of a job. Because of the size of our computer, a TRS-80 Model I with 32K bytes of memory, we wrote a program that analyzes the critical path but does not attempt to shorten it.

Three Time Estimates

Along each activity line in figure 1, you see three decimal numbers. Each

number represents a time expressed in weeks (though you could use any unit of time if you used the same unit for all items). The first of the three numbers represents the optimistic (minimum) estimated time required to complete the activity that the line represents; the second number represents the time that you expect will be required to complete the activity (the likely time); the third number represents the pessimistic (maximum) time, or the time the activity may require if everything goes wrong.

An example will clarify this. Line A in figure 1 connects event 1 to event 2. Line A stands for the activity of gathering and organizing the required accounting data. Event 2 is the completion of the accounting papers needed for construction of our foundation. The minimum time required for line A is estimated at one week, the likely time at two weeks, and the maximum time at three weeks; so the three values 1, 2, 3 are written on line A.

One reason PERT requires these three time estimates is that, as noted earlier, PERT originates from a research project. Since most research project activities are unprecedented, planners can't make a single, accurate estimate of the time each activity requires. The three estimated times are the basis for a statistical estimate of the probability of completing a project or an activity by any given time.

Applying PERT

Applying PERT is simple. A manager who can identify a project's critical path can control time and costs by concentrating on activities along the critical path. If an activity not on the critical path slips behind schedule, the slippage will not usually affect the time required to complete the entire project (although the slippage can hurt if the critical path shifts). Should an activity on the critical path slip, however, the time required to complete the project will increase and the project may be in trouble.

One obvious application of PERT is in making decisions about authorizing overtime on a specific activity. If

Text continued on page 473

Listing 1: *A program for PERT. Written in TRS-80 Level II Basic, the program asks a list of the activities in a project, the beginning and ending events of each activity, and estimates of the optimistic, most likely, and pessimistic durations of each activity. The program then uses statistical methods to find the critical path of the project, the time required to complete the critical path, and the probability of completing the project by any scheduled completion time.*

```
10 CLEAR 1000:CLS:REM  "PERt"
20 PRINT"PERT/CRITICAL PATH  SCHEDULING PROGRAM"
30 PRINT"DEVELOPED BY STEVEN M. ZIMMERMAN,PH.D.  & LEO M. CONRAD   1980"
40 INPUT"DISK SYSTEM OR LEVEL II BASIC (D/B)";S$
50 PRINT:PRINT"*** NOTE BEGINNING EVENTS WILL BE SORTED INTO NUMBERICAL ORDER *"
:INPUT"DIMENSION FOR ACTIVITIES";D%:PRINT
60 DIM A$(D%,2),A(D%,11),SV(11)
70 PRINT"INPUT MENU"
80 PRINT"      K      KEYBOARD"
90 PRINT"      D      DISK FILE"
100 PRINT"      R      READ STATEMENT"
110 PRINT"      T1     TAPE RECORDER #-1"
120 PRINT"      T2     TAPE RECORDER #-2"
130 INPUT"SELECTION";IO$
140 IFIO$<>"K"THEN 220
150 INPUT"NUMBER OF ACTIVITIES";M%:EE=0
160 PRINT"THIS IS GOING TO BE WORK YOU MUST NOW INPUT UP TO ";M%;"              AC
TIVITIES"
170 FOR I=1 TO M%
180 INPUT"ACTIVITY CODE ";A$(I,1)
190 INPUT"DESCRIPTION, BEGINING EVENT NUMBER, END EVENT NUMBER, MOST OPTIMISTIC
TIME, MOST LIKELY TIME AND MOST PESSIMISTIC TIME";A$(I,2),A(I,1),A(I,2),A(I,3),A
(I,4),A(I,5)
200 NEXTI
210 GOTO480
220 IFIO$="T1"ORIO$="T2"THEN230  ELSE330
230 PRINT"SETUP TAPE #-";IO&;" TO PLAY":REM  TAPE INPUT
240 IF S$="D"CMD"T"
250 IFIO$="T1"INPUT#-1,M%,EE
260 IFIO$="T2"INPUT#-2,M%,EE
270 FORI=1TOM%
280 IFIO$="T1"INPUT#-1,A$(I,1),A$(I,2):INPUT#-1,A(I,1),A(I,2),A(I,3),A(I,4),A(I,
5)
290 IFIO$="T2"INPUT#-2,A$(I,1),A$(I,2):INPUT#-2,A(I,1),A(I,2),A(I,3),A(I,4),A(I,
5)
300 NEXTI
310 IFS$="D"CMD"R"
320 GOTO480
330 IFIO$<>"D"THEN420
340 LINEINPUT"NAME OF FILE:DISK ";B$:REM  DISK INPUT
350 OPEN"I",1,B$
360 INPUT#1,M%,EE
370 FORI=1TOM%
380 INPUT#1,A$(I,1),A$(I,2),A(I,1),A(I,2),A(I,3),A(I,4),A(I,5)
390 NEXTI
400 CLOSE1
410 GOTO480
420 IFIO$<>"R"THEN70
430 READM%,EE
440 FORI=1TOM%:REM  READ INPUT
450 READA$(I,1),A$(I,2),A(I,1),A(I,2),A(I,3),A(I,4),A(I,5)
460 IFA$(I,1)="END"THEN480
470 NEXTI
480 REM PRINTS INPUT DATA FOR VERIFICATION
490 M=M%:TP=0:FORI=1TOM:IFA(I,2)>TPTHENTP=A(I,2)
495 NEXT:EE=TP
500 FORI=1TOM-1
510 FORJ=I+1TOM
520 IFA(I,1)<=A(J,1)THEN550
```

Listing 1 continued on page 470

Listing 1 continued:

```
530 FORK=1TO11:SV(K)=A(I,K):A(I,K)=A(J,K):A(J,K)=SV(K):NEXTK
540 FORK=1TO2:SV$(K)=A$(I,K):A$(I,K)=A$(J,K):A$(J,K)=SV$(K):NEXTK
550 NEXTJ,I
560 XX=5:PRINT"VERIFICATION OF INPUT"
570 Z1$="CODE DESCRIPTION EXPECTED EARLY    EARLY    LAST      LAST     SLACK"
580 Z2$="                 TIME     START    FIN      START     FIN      TIME"
590 Z3$="CODE DESCRIPTION BEGIN  END   OPTIMIST LIKELY  PESSI"
600 Z4$="                EVENT  EVENT  TIME     TIME    TIME"
610 PRINT"NO ";Z3$
620 PRINT"   ";Z4$
630 K=0
640 C4$="### "
650 FORI=1TOM%
660 PRINTUSINGC4$;I;
670 C1$=" #### "
680 C2$="%  % %         %":C3$=" ####.## "
690 PRINTUSINGC2$;A$(I,1),A$(I,2);
700 FORJ=1TO2
710 PRINTUSINGC1$;A(I,J);:NEXTJ
720 FORJ=3TO5
730 PRINTUSINGC3$;A(I,J);:NEXTJ
740 K=K+1:IFK>=13 THENPRINT:INPUT"ENTER TO PAGE";DU$:K=0
750 PRINT:NEXTI
760 INPUT"-2 TO ADD,  -1 TO CONTINUE OR NUMBER TO CHANGE";L:IFL=-1THEN810
770 IFL<>-2THEN790
780 L=M%+1:M%=L:N%=N%+1
790 INPUT"INPUT CODE, DESCRIPTION, BEGINNING EVENT NUMBER, END EVENT       NUMBER
, MOST OPTIMISTIC TIME, MOST LIKELY TIME AND THE MOST     PESSIMISTIC TIME";A$(L
,1),A$(L,2),A(L,1),A(L,2),A(L,3),A(L,4),A(L,5)
800 GOTO480
810 INPUT"HARD COPY OF INPUT DATA (Y/N)";P$
820 IFP$<>"Y"THEN960
830 INPUT"TITLE";T$:LPRINT"TITLE: ";T$
840 INPUT"DATE";T$:LPRINT"DATE: ";T$
850 LPRINT"NO ";Z3$
860 LPRINT"   ";Z4$
870 FORI=1TOM%
880 LPRINTUSINGC4$;I;
890 LPRINTUSINGC2$;A$(I,1),A$(I,2);
900 FORJ=1TO2
910 LPRINTUSINGC1$;A(I,J);:NEXTJ
920 FORJ=3TO5
930 LPRINTUSINGC3$;A(I,J);:NEXTJ
940 LPRINT" "
950 NEXTI
960 REM NOW THE WORK BEGINS  BEGINNING EVENT IS 1 EARLY START =0  FOWARD PASS
970 FORI=1TOM%
980 A(I,6)=(A(I,3)+4*A(I,4)+A(I,5))/6
990 IFA(I,1)=1THENA(I,7)=0:A(I,8)=A(I,6):GOTO1070
1000 MAX=0.0
1010 FORJ=1TOM%
1020 IFA(J,2)<>A(I,1)THEN1050
1030 IFA(J,8)>MAXTHENMAX=A(J,8)
1040 A(I,7)=MAX
1050 NEXTJ
1060 A(I,8)=A(I,7)+A(I,6)
1070 NEXTI
1080 REM BACKWARD PASS
1090 XM=0.0
1100 FORI=M%TO1STEP-1
1110 IFA(I,2)<>EETHEN1130
1120 IFXM<A(I,8)THENXM=A(I,8)
1130 NEXTI
1140 FORI=M%TO1STEP-1
1150 IFA(I,2)=EETHENA(I,10)=XM:GOTO1220
```

Listing 1 continued:

```
1160 MIM=99999
1170 FORJ=M%TO1STEP-1
1180 IFA(I,2)<>A(J,1)THEN1210
1190 IFA(J,9)<MIMTHENMIM=A(J,9)
1200 A(I,10)=MIM
1210 NEXTJ
1220 A(I,9)=A(I,10)-A(I,6)
1230 NEXTI
1240 REM SLACK VARIABLE CALCULATIONS
1250 FORI=1TOM%
1260 A(I,11)=A(I,10)-A(I,8)
1270 NEXTI
1280 K=0:REM PRINT OUTPUT
1290 PRINT"CODE DESCRIPTION EXPECTED EARLY  EARLY  LAST  LAST  SLACK"
1300 PRINT"                  TIME     START  FIN    START FIN   TIME"
1310 C5$=" ###.##"
1320 FORI=1TOM%
1330 PRINTUSINGC2$;A$(I,1),A$(I,2);
1340 FORJ=6TO11
1350 PRINTUSINGC5$;A(I,J);:NEXTJ
1360 PRINT:K=K+1:IFK=13INPUT"ENTER TO PAGE";DU$:K=0
1370 NEXTI
1380 INPUT"HARD COPY OF RESULTS (Y/N)";P$:IFP$<>"Y"THEN1450
1390 LPRINT" ":LPRINTZ1$:LPRINTZ2$
1400 FORI=1TOM%
1410 LPRINTUSINGC2$;A$(I,1),A$(I,2);
1420 FORJ=6TO11
1430 LPRINTUSINGC3$;A(I,J);:NEXTJ
1440 LPRINT" ":NEXTI
1450 PRINT"OUTPUT MENU"
1460 PRINT"     C     CRITICAL PATH AND TIME"
1470 PRINT"     D     DISK"
1480 PRINT"     E     END"
1490 PRINT"     R     RECYCLE"
1500 PRINT"     T1    TAPE#-1"
1510 INPUT"     T2    TAPE#-2         SELECTION ";OP$:IFOP$="R"THEN480
1520 IFOP$<>"C"THEN1690
1530 REM IDENTIFICATION OF CRITICAL PATH AND COSTS
1540 CO=0:PATH$=" ":SI=0
1550 FORI=1TOM%:IFA(I,11)>0.00001THEN1570 :REM  NOTE >0 SHOULD WORK BUT .00001 U
SED
1560 CO=CO+A(I,6):PATH$=PATH$+" "+A$(I,1):SI=SI+((A(I,3)-A(I,5))/6)[2
1570 NEXTI:C6$="###,###,###.##":SI=SQR(SI)
1580 CLS:PRINT"CRITICAL PATH":PRINTPATH$:PRINT
1590 PRINT"TIME OF CRITICAL PATH":PRINTUSINGC6$;CO:INPUT"SCHEDULED PROJECT TIME
(USE SAME TIME UNITS AS DATA)";ST:Z=(ST-CO)/SI:XX=0
1600 BB$="PROBABILITY OF BEING COMPLETED ON TIME":IFZ<0THEN1640
1610 A=.4361836:B=-.1201676:C=.937298:D=(2.7182818[(-Z[2/2))*(2*3.1415926)[(-.5)
:E=(1+.3326*Z)[(-1):P=1.-D*(A*E+B*E[2+C*E[3):IFXX>0THEN1630 :REM TAYLOR SERIES
1620 PRINT"Z= ";Z,BB$;P:GOTO1650
1630 PRINT"Z= ";-Z,BB$;1-P:GOTO1650
1640 XX=99:Z=-Z:GOTO1610
1650 INPUT"HARD COPY (Y/N)";P$:IFP$<>"Y"THEN1450
1660 LPRINT" ":LPRINT"CRITICAL PATH":LPRINT PATH$:LPRINT" ":LPRINT"SCHEDULED PRO
JECT TIME IS ";ST
1670 LPRINT"TIME OF CRITICAL PATH":LPRINTUSINGC6$;CO:IFXX=0LPRINT"Z= ";Z,BB$;P:G
OTO1450
1680 LPRINT"Z= ";-Z,BB$;1-P:GOTO1450
1690 IFOP$="E"THENEND
1700 IFOP$<>"D"THEN1750
1710 LINEINPUT"NAME OF FILE:DISK ";X$:OPEN"O",1,X$
1720 PRINT#1,M%,EE
1730 FORI=1TOM%:PRINT#1,CHR$(34);A$(I,1);CHR$(34);",";CHR$(34);A$(I,2);CHR$(34);
A(I,1);A(I,2);A(I,3);A(I,4);A(I,5):NEXTI
1740 CLOSE1:GOTO1450
```

Listing 1 continued on page 472

Listing 1 continued:

```
1750 IFS$="D"THENCMD"T"
1760 IFOP$="T1"PRINT#-1,M%,EE:FORI=1TOM%:PRINT#-1,A$(I,1),A$(I,2):PRINT#-1,A(I,1
),A(I,2),A(I,3),A(I,4),A(I,5):NEXTI
1770 IFOP$="T2"PRINT#-2,M%,EE:FORI=1TOM%:PRINT#-2,A$(I,1),A$(I,2):PRINT#-2,A(I,1
),A(I,2),A(I,3),A(I,4),A(I,5):NEXTI
1780 IFS$="D"THENCMD"R"
1790 GOTO1450
1800 REM PUT DATA HERE  FIRST # ACTIVITIES  THEN ENDING EVENT NUMBER THEN CODE,
DESCRIPTION,BEGINNING EVENT, ENDING EVENT, OPT. TIME, LIKELY TIME, PESS. TIME FO
R EACH ACTIVITY.
1810 DATA18,9
1820 DATA A,ACCT. PAPERS,1,2,1,2,3
1830 DATA Z,PERMITS,2,7,4,5,8
1840 DATA B,SHOP BANKERS,1,3,2,4,6
1850 DATA C,SHOP REAL EST.,1,4,2,13,17
1860 DATA D,MARKET STUDY,2,3,2,4,5
1870 DATA G,CONTRACTOR,2,5,1.4,2.2,6.7
1880 DATA F,INSURANCE,2,6,.4,1.3,1.5
1890 DATA H,ART. PLANS,3,5,2,4,6
1900 DATA E,COST STUDY,3,4,3,4,5
1910 DATA I,LAND,4,5,8,11,13
1920 DATA J,MATERIAL,5,6,2,3,4
1930 DATA K,PLANS,5,7,2,5,12
1940 DATA L,SURVEY,5,8,1,2,4
1950 DATA M,BUY MAT #1,6,8,2,3,4
1960 DATA O,BUY MAT #2,6,9,1,2,5
1970 DATA N,LAYOUT,7,8,9,11,12
1980 DATA P,FOUNDATION,8,9,1,3,6
1990 DATA Q,HIRE CREW 2,7,9,1,2,3
```


 Circle 151 on Inquiry card. Circle 156 on Inquiry card.

Text continued from page 468:

the activity is not on the critical path, a manager's decision to authorize expenditures for overtime would be foolish and wasteful. All activities not on the critical path have "slack time," the difference between the earliest and latest expected finish. By definition, only the activities on the critical path have zero slack time. We'll elaborate later.

Our PERT Program

Our PERT program is shown in listing 1. A dimension (DIM) statement at line 60 provides places to store data on activities. The same DIM statement also provides storage for a dummy variable, SV, to be used later during sorts.

On a system with 32K bytes of memory and two disk drives, our program can handle more than 200 activities. We have yet to need more than 100 activities. Your machine's memory capacity and the limits of your DIM statement will determine the size of the problem that our program can handle for you. You can find the limits by experimentation.

One way to save memory is to carefully omit remark (REM) statements. We used REM statements to index some of our GOTO statements; you must send the GOTO to the line following any REM statement you drop. Another approach divides the problem into subproblems and treats each subproblem separately. If you can't reduce the problem's memory demands, you can always use the PERT program to determine how to obtain a machine with 48K bytes of memory.

As noted before, the critical path consists of a series of activities that have zero slack time. To find the critical path, you must identify activities that have zero slack time. The program output, consisting of two tables, is designed to identify these activities.

The first table (see listing 2) shows the program's input, listing all the activities in the project, their beginning and ending events, and the three estimates of the time each activity requires. You should check your input whenever you use this program, because otherwise you may get crazy results.

The second table (see listing 3) is the program's output. Notice the last column, "Slack Time." Zeros in this column identify the critical path. You can, of course, trace the activities in the critical path by looking in the first column, "Code," for each activity with zero slack time. But our pro-

Listing 2: *A printout of the input for the PERT program sample run shown in listing 1. Input includes the beginning and ending event of each activity and three estimates of the time each activity requires.*

```
TITLE: SAMPLE PROBLEM
DATE: 01/19/81
NO CODE DESCRIPTION BEGIN  END    OPTIMIST LIKELY  PESSI
                    EVENT  EVENT  TIME     TIME    TIME
 1  A   ACCT. PAPE   1      2       1.00     2.00    3.00
 2  B   SHOP BANKE   1      3       2.00     4.00    6.00
 3  C   SHOP REAL    1      4       2.00    13.00   17.00
 4  Z   PERMITS      2      7       4.00     5.00    8.00
 5  D   MARKET STU   2      3       2.00     4.00    5.00
 6  G   CONTRACTOR   2      5       1.40     2.20    6.70
 7  F   INSURANCE    2      6       0.40     1.30    1.50
 8  H   ART. PLANS   3      5       2.00     4.00    6.00
 9  E   COST STUDY   3      4       3.00     4.00    5.00
10  I   LAND         4      5       8.00    11.00   13.00
11  J   MATERIAL     5      6       2.00     3.00    4.00
12  K   PLANS        5      7       2.00     5.00   12.00
13  L   SURVEY       5      8       1.00     2.00    4.00
14  M   BUY MAT #1   6      8       2.00     3.00    4.00
15  O   BUY MAT #2   6      9       1.00     2.00    5.00
16  N   LAYOUT       7      8       9.00    11.00   12.00
17  Q   HIRE CREW    7      9       1.00     2.00    3.00
18  P   FOUNDATION   8      9       1.00     3.00    6.00
```

gram also provides a menu option C CRITICAL PATH AND TIME, which prints both the critical path and the time required to complete it.

A word of caution about using the program: round-off problems in cal-

PERT and CPM

The Performance Review and Evaluation Technique (PERT) and the Critical-Path Method (CPM) are managerial tools that emerged in the late 1950s. Both PERT and CPM rely on network diagrams to analyze projects. PERT was developed to guide the management of complex research and development projects.

By their nature, such projects have no precedents to guide planners in estimating how long each activity in a project will take. Planners must resort to statistical methods to estimate actual performance time. PERT's developers wanted to know how long a project could be expected to last and, given a scheduled completion date, what probability there was of actually meeting the date.

CPM, on the other hand, was developed by duPont and Remington Rand Univac to determine how time required for routine construction and maintenance can be reduced. Here experience can serve as a guide for estimating the time required for each activity in a project. CPM assumes these are reliable estimates and concentrates on determining the optimal trade-off of total time required for a project and the total cost of a project. Rather than asking how long the project will probably take or what chance there is of meeting a schedule, CPM seeks to determine a project schedule to minimize direct and indirect costs. (An example of an indirect cost is production time lost while a manufacturing plant closes for maintenance.)

An article entitled "Programming the Critical-Path Method in BASIC" by Dr. Zimmerman and Mr. Conrad will appear in the July issue of BYTE. That article will use the same construction project that appears as a sample case in this article. Although the routine character of the project makes it better suited to analysis by CPM than by PERT, the authors chose to use the same example for both articles to show the similarities and contrasts between the two managerial techniques. . . . **P.L.**

culating the critical path forced us to define zero slack time as 0.00001 instead of true zero. Where small differences are important, this approximation of zero can cause problems. The value 0.00001 is entered at line 1550; perhaps you can change the value to true zero for some of your applications. Furthermore, since we used statistical methods to determine the probability of a project's being completed on time, given a scheduled completion date, you should remember that data generated by the program is based on estimates and is itself an estimate.

Running the Program

The easiest way to input data is to use DATA statements at the end of the program. Entering data from the keyboard takes time and increases the number of errors. The following description of a program run assumes that DATA statements were used for input.

The data needed (see listing 2) include the name of each activity, its beginning and ending events, and the optimistic, likely, and pessimistic estimates of the activity's length.

Whether you input data from DATA statements or the keyboard,

Listing 3: *Output of the PERT program sample run in listing 1. Activities on the critical path are identified by zero slack time (shown in column on far right), where slack time is the difference between earliest (column 5) and lastest (column 7) expected finish. The program has printed the critical path, C I K N P, the project's expected duration (42.3333 weeks), and the probabilities of project completion in 35 weeks and 50 weeks.*

```
CODE DESCRIPTION EXPECTED EARLY     EARLY    LAST      LAST     SLACK
                 TIME     START     FIN      START     FIN      TIME
A    ACCT. PAPE    2.00      0.00     2.00     2.00      4.00     2.00
B    SHOP BANKE    4.00      0.00     4.00     3.83      7.83     3.83
C    SHOP REAL    11.83      0.00    11.83     0.00     11.83     0.00
Z    PERMITS       5.33      2.00     7.33    23.00     28.33    21.00
D    MARKET STU    3.83      2.00     5.83     4.00      7.83     2.00
G    CONTRACTOR    2.82      2.00     4.82    19.85     22.67    17.85
F    INSURANCE     1.18      2.00     3.18    34.98     36.17    32.98
H    ART. PLANS    4.00      5.83     9.83    18.67     22.67    12.83
E    COST STUDY    4.00      5.83     9.83     7.83     11.83     2.00
I    LAND         10.83     11.83    22.67    11.83     22.67     0.00
J    MATERIAL      3.00     22.67    25.67    33.17     36.17    10.50
K    PLANS         5.67     22.67    28.33    22.67     28.33     0.00
L    SURVEY        2.17     22.67    24.83    37.00     39.17    14.33
M    BUY MAT #1    3.00     25.67    28.67    36.17     39.17    10.50
O    BUY MAT #2    2.33     25.67    28.00    40.00     42.33    14.33
N    LAYOUT       10.83     28.33    39.17    28.33     39.17     0.00
Q    HIRE CREW     2.00     28.33    30.33    40.33     42.33    12.00
P    FOUNDATION    3.17     39.17    42.33    39.17     42.33     0.00



CRITICAL PATH
  C I K N P

SCHEDULED PROJECT TIME IS  42.3333
TIME OF CRITICAL PATH
         42.33
Z=  0            PROBABILITY OF BEING COMPLETED ON TIME .5

CRITICAL PATH
  C I K N P

SCHEDULED PROJECT TIME IS  35
TIME OF CRITICAL PATH
         42.33
Z= -2.24537      PROBABILITY OF BEING COMPLETED ON TIME .0123852

CRITICAL PATH
  C I K N P

SCHEDULED PROJECT TIME IS  50
TIME OF CRITICAL PATH
         42.33
Z=  2.34743      PROBABILITY OF BEING COMPLETED ON TIME .990536
```

the program begins by giving an identification message and then asks:

DISK SYSTEM OR LEVEL II BASIC (D/B)?

Our example will work the same way whichever answer you give. The program next asks the number of activities, using the answer as the basis for a dimension statement. As noted earlier, you must have enough memory to dimension the number of activities in your project.

The program presents the message:

*** NOTE BEGINNING EVENTS WILL BE SORTED INTO NUMERICAL ORDER *

when asking

DIMENSION FOR ACTIVITIES?_

As you see in listing 2, events are arranged according to the earliest starting event in each activity, and ties are broken by reference to the earliest ending event for each activity.

Now the program presents the input menu:

```
         INPUT MENU
K    KEYBOARD
D    DISK FILE
R    READ STATEMENT
T1   TAPE RECORDER#-1
T2   TAPE RECORDER#-2
       SELECTION?_
```

Option R causes the program to read DATA statements at the end of the program. After a brief delay, the program will display for verification the input that was read.

The video display of the input will look slightly different than the table in listing 2 because of differences in the screen and printer sizes. If a single screen won't accommodate all the input, the program will ask you to page through.

After listing all the input, the program will say:

−2 ADD, −1 TO CONTINUE OR NUMBER TO CHANGE?_

The number referred to is the number

of any activity that you wish to change. Assuming you want to continue and enter −1, the program will ask:

HARD COPY OF INPUT
DATA (Y/N)?__

If you request hard copy, the program will ask

TITLE?__
DATE?__

and will print your responses at the top of the page. Our sample set of data used the title SAMPLE PROBLEM and the date 01/19/81.

After the input is printed, the screen will display the results, as shown in listing 3. For each activity, you will see computations of how long it should be expected to take, the earliest week it can start, the earliest week it can finish, the last week it can start, the last week it can finish, and the slack time (the difference between the earliest and latest possible finish). You may have to page through a screen display of this data. The program will again ask if you want hard copy.

Then you will see:

OUTPUT MENU
C CRITICAL PATH AND TIME
D DISK
E END
R RECYCLE
T1 TAPE#−1
T2 TAPE#−2
SELECTION?__

Option C, for our example, results in a display like the following:

CRITICAL PATH
C I K N P
TIME OF CRITICAL PATH
42.33
SCHEDULED PROJECT TIME
(USE SAME TIME UNITS AS
DATA)?__

For our example, the critical path consists of shopping for a real-estate agent, obtaining land, getting architectural plans, getting a detailed

layout for construction, and actually building the foundation. The time of the critical path is expected to be 42.33 weeks.

You can now input the scheduled time for the project, and the program will use the Z calculations explained in the textbox "A Glance at the Mathematics of PERT" to tell you the probability of meeting the schedule. As shown in listing 3, there is a 0.0123852 probability of finishing in 35 weeks and a 0.990536 probability of finishing in 50 weeks. As noted earlier, there is also a 0.500 probability of finishing in the expected time of the critical path—42.33 weeks.

Conclusion

If you need help planning and scheduling complex projects, our PERT program can provide it. You can use it without knowing how to perform the calculations involved. Although we repeat our caution about relying on estimate-based estimates, we still believe PERT has proved itself a valuable managerial tool and that our program accurately represents PERT.■

A Glance at the Mathematics of PERT

The mathematics of PERT involves some interesting statistical concepts. You don't have to understand the mathematics to use PERT, but it helps you to understand how our program works.

First, we must refresh your recollection of some basic statistical terms. The mean *of a set of occurrences of some variable is the arithmetic average of the values of the occurences; the* standard deviation *shows the variability of occurrences from the mean (more precisely, the standard deviation is the square root of the mean of the squares of the deviations of individual occurrences from the mean); the* variance *is the square of the standard deviation.*

For example, if we have three values 9, 12, and 15, their mean is 36/3 = 12, their variance is

$$(9\text{-}12)^2 + (12\text{-}12)^2 + (15\text{-}12)^2 = 18$$

and the standard deviation is the square root of 18, which is approximately 4.24.

It is a common statistical assumption that the standard deviation in unimodal distributions (distributions that have only a single most-likely-occurring value) is roughly a sixth of the range of distribution. The basis for this estimate is the fact that 89 percent or more of any distribution lies within three standard deviations of the mean; and for the normal distribution, 99.7 percent of the distribution lies within three standard deviations of the mean.

Since we have estimates of the minimum time a *and the maximum time* b *required to complete an activity, we have established an estimated range of actual times. We can estimate the standard deviation of the actual time as:*

$$\frac{(b-a)}{6}$$

Since PERT assumes that chance, or random, factors will influence the actual time needed to complete an activity, we can expect the actual times to be distributed along some curve. PERT assumes that the mean actual time will follow the distribution known as the beta distribution, which is contained in a finite interval and may be either symmetric or skewed. Our most likely time of completion m *is the mode of the curve for each activity. The following equation, based on the assumption that our formula for the standard deviation is correct, is a linear approximation of the value of the expected value, EV, of the mean time:*

$$EV=\frac{(a+4\times m+b)}{6}$$

As you can see, this is just a weighted average, counting the minimum and the maximum each once and the mode four times, then dividing the total by six. On line 980 of listing 1, the same equation is expressed as:

$$A(I,6)=(A(I,3)+4*A(I,4)+A(I,5))/6$$

The following equation gives the variance of the beta distribution for each activity:

$$VAR=((b-a)/6)^2$$

For each activity, the program applies the statistical principles described above and calculates the time the activity should last, the earliest time at which it can start, the earliest finish, the latest start, and the latest finish. Calculation of the earliest start and finish times is called the "forward pass" and takes place in our program at lines 960 through 1070. Calculation of the latest start and finish is called the "backward pass" and takes place at lines 1080 through 1230.

The difference between the earliest and latest projected finish for each activity is called "slack time." At lines 1240 through 1270, the program calculates slack time for each activity. The events that have zero slack time form the critical path.

To obtain the approximate variance for the critical path, add the variances of the activities on the path:

$$VAR(Path)=VAR(1)+VAR(2)\ \ldots + VAR(n)$$

It happens that the Central Limit theorem enables us, based on the foregoing, to assume that the distribution of the time required to complete the critical path is normal. Based on this assumption, we can calculate the probability of the project's being on time, given some specified target completion time. The calculation's basis is the deviation of the scheduled completion time from the estimated mean completion time, with the deviation measured in units of standard deviations. This deviation is called Z. The Z calculation for the standard normal table is:

$$Z=\frac{\left(\text{scheduled time} - \text{time of critical path}\right)}{VAR(path)}$$

Rather than require you to use normal tables with our program, we have built in a Taylor series to approximate the tables. (A Taylor series is a power series that gives the expansion of a function f(x) in the neighborhood of a point a*, provided all derivatives exist and the series converges.) The Taylor series is located at line 1600 and following in our program.*

The expected time of the critical path is the sum of the expected times of all the activities on the path. If the scheduled time of the project equals the expected time of the critical path, you have a 50 percent chance of completing the project on time.

CP/M, Your Time Has Come

A real-time clock for the most popular microcomputer operating system.

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Have you ever looked with envy at big computers that have built-in, real-time clocks? If so, this project may be for you. We had a business program that required such a clock, but the application neither warranted the expense of a clock board nor required split-second accuracy. We needed a time-of-day reference rather than a precise generator of program interrupts and we needed to be able to access the clock and print the time from either the operating system or a BASIC program. We wanted something like the clock in Digital Research's MP/M, but we also wanted our clock to work with earlier versions of CP/M.

The project turned out to be reasonably easy to implement in both hardware and software. Anyone running CP/M with a disk drive and a Z80 or 8080 processor can have a clock like ours with little difficulty. The part of the project that requires the most care is integrating the software into the existing CP/M system. If you're rusty at using CP/M's DDT (debugger), ED (editor), and ASSEMBLER programs, here is a chance to practice on a worthwhile project.

Building the Clock Hardware

Figure 1 shows all the hardware we need. The unregulated +8 V power bus in most computers has a lot of 120-cycle ripple riding on top. We differentiate this ripple with a condenser (C1) and a resistor (R1). By

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Ben Hill is president of Teleshows Inc, which provides television production services to the industry. He is interested in music and photography and has a special interest in business applications for computers. His equipment is a three-disk S-100 system with a Perkin-Elmer OWL terminal and a Diablo printer.

feeding the result into a high-gain LM324 operational amplifier (IC1), wired as a comparator, we get a 120-cycle pulse output. (The output isn't quite symmetrical, but that's not a problem in this application.)

Now that we have pulses to count, the rest of the hardware is easy. The 7490 (IC2) is used as a divide-by-10 counter, and its output feeds the 7492 (IC3), which is connected as a divide-by-12. The result: a divide-by-120 and one pulse per second on the output of the counter chain. Thanks to your friendly utility company, the pulse is accurate to 0.05%.

This one-second pulse is now fed to a 7400 NAND gate (IC4). Two of the gates in this device are connected as a familiar set/reset latch. Another gate is used to invert the processor interrupt-acknowledge pulse (SINTA, pin 96 on the S-100 bus). The diode on the POC (power-on clear) line (pin 99 on the S-100 bus) allows setting the latch on power-up but prevents the acknowledge pulse from feeding back down the POC line. Since the count pulse is too wide, we differentiate it with a condenser (C2) and a resistor (R2) and then feed it to pin 5 of IC4. The output of the latch (pin 3) is fed to the PINT (processor-interrupt) line (pin 73 on the S-100 bus). In operation, the clock pulse triggers the latch and PINT goes low. It stays low until the processor acknowledges the interrupt via SINTA and again presets the latch.

We could use a faster pulse time, but it would complicate the project. Each disk access by a running program will disable the interrupts. If clock pulses came in at a faster rate—say 60 times a second—then some method would have to be devised to keep track of those pulses occurring during disk access. Otherwise the pulses that occurred while the interrupts were disabled would be lost and the clock would lose time. Fortunately, disk-access times are usually less than 1 second. Since the latch will hold the clock request that long, the processor will recognize the clock pulse when the disk controller turns the interrupts back on.

The switch on the PINT line is there so that you can disable the clock. Some programs enable interrupts. DDT

is an example. Since DDT uses the same restart instruction as the clock program (RST.7), you must disable the clock to prevent mutual interference whenever you use DDT. Furthermore, if you use interrupts in your system, you won't be able to use the hardware described here.

You can construct the circuit using space on one of your boards or on a piece of perf-board. The layout is not critical. You can use either wire-wrap or point-to-point wiring with solder. When you complete your board, check for a one-second pulse at pin 3 of the 7400. If you have it, your clock hardware is working properly.

Clock Software

The clock software consists of four parts:

- code that establishes an area in memory to act as a communications link between the BIOS (basic input/output system) and the clock program on disk
- a program that controls, sets, and reads the clock
- modifications in the BIOS to prepare it for handling the clock-generated interrupts
- code that adds BIOS to the clock routines that are accessed during each interrupt to update the time

If you have a listing of your BIOS, now is the time to dust it off and use it. If you don't have a listing, get the name of your BIOS file from your system manual and print a listing to use as a reference while implementing this clock. You can print the listing by using the TYPE command on the ASM file that contains the BIOS or on the PRN file produced by assembling the file.

Note that some of the file names used in this article may not match the names used in your system. To prevent confusion, we describe file references as fully as possible.

Establishing a Communications Area

There are 16 unused bytes in CP/M's BIOS, starting at address 40 hexadecimal. We will use 7 bytes of this for our communications area. But first, look at the EQUATES or SYMBOL TABLE section at the beginning of your freshly printed BIOS. See if any of the labels or equate statements use address 40. If none does, then you are free to use any of those 16 bytes. If some of the locations are used, don't write over them or you will "clobber" your operating system. Instead, pick another location. The CP/M manual lists the addresses that are free in low memory. Look in the section called the CP/M

Number	Type	+5V	GND
IC1	LM324	4	11
IC2	7490	5	10
IC3	7492	5	10
IC4	7400	14	7

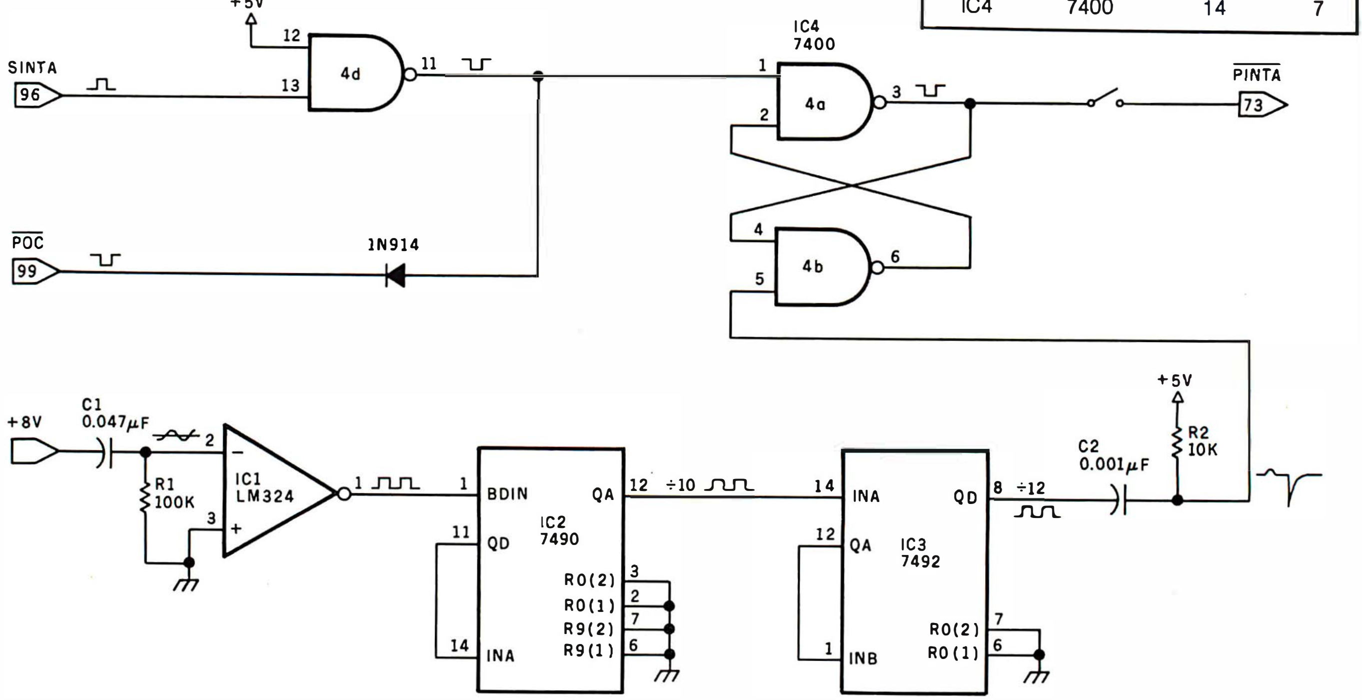


Figure 1: *The hardware required to generate the clock interrupts for the CP/M clock programs. This design uses the inherent stability of the AC line to generate accurately timed pulses. The LM324 sees the few hundred millivolts of AC ripple riding on top of the computer's +8 V supply and makes a pulse out of it. Using this approach makes it unnecessary to bring AC into the board. The counters divide the pulse down to one per second.*

Alteration Guide, under the heading "Reserved Locations in Page Zero."

You don't have to use the locations at 0040 hexadecimal, or even low memory for that matter. You can use any location that isn't reserved by CP/M. If you decide to use a high-memory location (i.e., above the BIOS), remember that you will have to change the addresses of all programs that use the clock whenever the size of the CP/M system is changed. Also, whatever location you do choose will become the value to be used in the TIME program equate: BASE.

Assuming we have picked 0040 hexadecimal as the starting location for our communications area, here is how hexadecimal addresses are employed: the address of the clock routine is stored at 0040 and 0041. This is set by the BIOS and is used by the time program when starting the clock. The clock ON/OFF flag is at 0042 (ON=1, OFF=0), 0043 is the seconds register, 0044 is the minutes register, 0045 is the hours register, and 0046 is the AM/PM flag (AM=0, PM=FF).

The TIME Program

TIME is a short machine-language program that resides permanently on your system disk. In addition to reading and setting the clock, TIME checks to see if the BIOS has the code to handle the required interrupts. TIME also checks for valid time entries from the terminal.

As a command file, TIME may be called in response to CP/M's prompt. The time-of-day registers maintained by the BIOS may also be read by a BASIC program that uses the PEEK instruction. The clock may be called as often as desired with either method, but the actual starting and stopping of the clock can be done only in TIME's command mode.

To set the time and start the clock with this program, get the A> prompt, and then type:

TIME 120000PM (or any valid 12-hour clock time)

The program will respond with:

START CLOCK BY PRESSING RETURN

When return is pressed, the clock is started and the following message is displayed:

TIME SET TO = 12:00:00 PM (the set time)

The clock is now running and will continue to run without intervention. The clock won't interfere with your other programs unless they require the use of interrupts.

To read the time, type:

TIME

The program will display the time in this format:

12:00:15 PM

To stop the clock, type:

TIME STOP

This will stop the clock and display a message like:

STOPPED AT 12:00:15 PM

When you start the clock again, you must, of course, reset it. There is no provision for a split-time register.

Modifications

Now that we have a clock pulse, a program to process it, and a place in memory to store it, we need a few changes in the system BIOS to make it all work. The areas in BIOS that are affected by the clock program are as follows:

- The EQUATE area. We need to add EQUATES to tell the assembler what addresses we have chosen for the communications section.
- The cold boot (bootstrap) routine. When initializing the system or using the cold boot start, RST-7 has not yet been set up, so the clock must be disabled by setting the ON/OFF flag to OFF (0).
- The GOCPM area in the BIOS is used at program exits and by both cold and warm boots. During the cold boot, the ON/OFF flag is set to 0 and the interrupts are not turned on. With a warm boot, however, we don't know whether the clock is ON or OFF, so we check it. The program then decides what to do: either turn the clock OFF, or leave it OFF if it already is.
- The SETUP routine section sets up jumps into CP/M in low memory. Since the CP/M size changes if you add memory, we add a bit of code here to tell the communications area the address of the clock in BIOS. The TIME program, which sets up the restart address-link to the BIOS clock, must get the address from the communications area.
- The READ and WRITE routines. If the disk controller does not use DMA (direct memory access), or if it does but uses it in the direct-transfer mode, we must disable the interrupts while we are doing a read or write to disk. The code entered here turns off the interrupts and then turns them back on again as soon as possible to avoid losing any counts. Check your disk-controller manual to see what kind of read/write system it uses. If your controller tolerates interrupts during the read/write cycles, then you need not implement this section of code.
- Add the clock coding to BIOS. The program in listing 1 provides the coding necessary to handle and service the clock interrupts. At the end of this code is a short section called INTON. This code saves the processor status in a register, then checks the ON/OFF locations. If the clock ON/OFF location is ON (1), the interrupts are enabled. If the clock is OFF (0), the interrupts are left disabled. Note again that if your terminal or printer input/output routines in BIOS use interrupts, you will not be able to implement this clock.

The preceding summarizes the changes needed in BIOS to implement the clock. The clock counter is kept in binary-coded-decimal form. The lower 4 bits of each byte hold the units of time, while the upper 4 bits hold tens of units. Since there is no way of knowing how much stack space your system has allowed, the interrupt handler routine is coded as simply as possible.

Putting It All Together

The new code to be added to the BIOS is shown in listing 1. It is generally compatible with all versions of CP/M, but in version 2.0 and later, make sure that adding this code doesn't exceed the BIOS size allowed by your system.

To start, find the equivalent code in your listing, and with your editor call up your CBIOSXX.ASM (where C stands for "custom" and XX is the size of your system). Put in the new EQUATES at any convenient location in your BIOS EQUATE area, and follow listing 1 for the rest of the new code. Remember: don't write over or delete any code in your BIOS. Just make additions.

After you have made the changes, save the file. This will give you a new CBIOSXX.ASM file that contains the additions. Starting at this point you should work on a

Text continued on page 486

Listing 1: *The clock program that is added to the CP/M BIOS. It enables the system BIOS to handle the one-a-second interrupts generated by the clock hardware and maintains the accumulated time in registers located in low memory. Once the clock is started, this program maintains the time registers without interference with other operating programs.*

```
; CLOCK PROGRAM BIOS CODE BY J. L. CALAWAY AND
; B. HILL.  FEB 10, 1981  LISTING #1  REVISION 1

; CODE TO BE ADDED TO THE SYSTEM BIOS TO IMPLEMENT THE
; CLOCK PROGRAM

; IN THE AREA USED BY BIOS TO SET THE VARIOUS EQUATES
; AND CONDITIONALS, WE ADD THE EQUATES NEEDED TO
; DEFINE THE CLOCK COMMUNICATIONS AREA
;

CLOCK   EQU     TRUE            ; ENABLE REAL-TIME-CLOCK
BASE    EQU     00040H          ; COMMUNICATIONS AREA
CLKADR  EQU     BASE            ; ADDRESS INITIATED BY BIOS
ONOFF   EQU     CLKADR+2        ; ON/OFF FLAG 0=OFF
SEC     EQU     ONOFF+1         ; BCD SECONDS
MIN     EQU     SEC+1           ; BCD MINUTES
HRS     EQU     MIN+1           ; BCD HOURS
AMPM    EQU     HRS+1           ; AM=0, PM=FF


; IN THE COLD BOOT SECTION
;
        XRA     A               ; EXISTING CODE, NO CHANGE
        STA     IOBYTE          ; EXISTING CODE, NO CHANGE

        IF      CLOCK           ; NEW CODE TO BE ADDED
        STA     ONOFF           ; SET ONOFF=0
        ENDIF                   ; END OF NEW CODE IN THIS SECTION


; IN THE GOCPM SECTION WHERE CONTROL IS TRANSFERED
; TO CP/M, WE ADD A CHECK TO SEE IF THE INTERRUPTS
; SHOULD BE ON, OR OFF
;
        LDA     DISKNO          ; EXISTING CODE, NO CHANGE
        MOV     C,A             ; EXISTING CODE, NO CHANGE

        IF      CLOCK           ; NEW CODE TO BE ADDED
        LDA     ONOFF           ; GET FLAG
        ORA     A               ; TEST
```

Listing 1 continued:

```
        JZ      CPMB              ; START WITHOUT INTERRUPTS
        EI                        ; TURN ON INTERRUPTS
        ENDIF                     ; END OF NEW CODE

        JMP     CPMB              ; BACK TO OLD CODE, NO CHANGE
; IN THE AREA WHERE A JUMP TO LOW MEMORY IS SETUP, WE
; SET CLKADR TO THE ADDRESS OF CLOCK
;
        SHLD    DMAADD            ; EXISTING CODE, NO CHANGE

        IF      CLOCK             ; ADDED CODE BEGINS
        LXI     H,CLK             ; ADDRESS
        SHLD    CLKADR
        ENDIF                     ; END OF NEW CODE

; NOTE, WE DO NOT NEED TO PUT A JUMP INSTRUCTION IN
; NOW, AS THAT IS DONE BY THE TIME PROGRAM, WHEN
; THE CLOCK IS STARTED


; IN THE WARM BOOT AREA, WE CHECK TO SEE IF
; THE USER PROGRAM HAS TURNED THE CLOCK OFF
;
WBOOT:  LXI     SP,80H            ; OLD CODE, NO CHANGE

        IF      CLOCK             ; NEW CODE STARTS HERE
        CALL    INTON             ; CHECK
        ENDIF                     ; END OF NEW CODE

        LDA     DISKNO            ; OLD CODE, NO CHANGE


; IN THE READ ROUTINE, SINCE MANY CONTROLLERS ARE NOT
; DMA, WE MUST TURN OFF THE INTERUPTS DURING THE
; ACTUAL READ PROCESS.

        XTHL                      ; EXISTING CODE, NO CHANGE
        XTHL                      ; EXISTING CODE, NO CHANGE

        IF      CLOCK             ; NEW CODE STARTS HERE
        DI                        ; KILL INTERUPTS
        ENDIF                     ; END OF NEW CODE

        LDA     SECTOR            ; EXISTING CODE, NO CHANGE


; NOW, AS SOON AS POSIBLE AFTER WE HAVE COMPLETED THE DISK
; TRANSFER, WE WANT TO TURN THEM BACK ON
;
RDDONE: IN      DSTAT             ; READ DISC STATUS, OLD BIOS CODE

        IF      CLOCK             ; NEW CODE STARTS HERE
        CALL    INTON             ; CHECK
        ENDIF                     ; END OF NEW CODE
; WE DO THE SAME THING FOR WRITE AS WE DID FOR READ
;
```

Listing 1 continued on page 484

Listing 1 continued:

```
        XTHL                        ; EXISTING CODE, NO CHANGE
        XTHL                        ; EXISTING CODE, NO CHANGE

        IF      CLOCK               ; NEW CODE STARTS HERE
        DI                          ; TURN OFF
        ENDIF                       ; END NEW CODE

; AND AGAIN, BACK ON AS SOON AS POSIBLE
;
WDONE:  IN      DSTAT               ; OLD CODE, NO CHANGE

        IF      CLOCK               ; NEW CODE HERE
        CALL    INTON               ; CHECK - TURN BACK ON
        ENDIF                       ; END NEW CODE


; THIS IS THE ACTUAL CLOCK SUBROUTINE TO BE ADDED TO THE BIOS.
; IT MAY BE PLACED ANYWHERE IN BIOS PROVIDING YOU DON'T BREAK
; UP A BIOS SUBROUTINE.  A GOOD PLACE TO PUT IT IS AT THE END
; OF THE PROGRAM JUST BEFORE THE CBIOS MESSAGES.

; CLOCK TIME IS KEPT IN BCD FORMAT AND
; IN LINE CODE IS USED TO MINIMIZE STACK USAGE.
;
; (NOTE: THE 3RD AND 4TH LOCATION FROM THE
; START OF CLK, IS CHECKED BY THE "TIME" PROGRAM BEFORE
; TURNING THE CLOCK ON AND IT MUST BE THE SAME AS THE ADDRESS
; IN THE TIME PROGRAM USED FOR SECONDS.)
;

        IF      CLOCK

CLK:    PUSH    PSW                 ; SAVE USER
        PUSH    H
        LXI     H,SEC               ; SECONDS
        MOV     A,M                 ; GET CURRENT
        ADI     1                   ; + 1
        DAA                         ; BCD CORRECTION
        MOV     M,A                 ; PUT IT BACK - DATA MAY BE GOOD
        CPI     060H                ; BCD FOR 60 SEC
        JNZ     CLK2                ; OK, EXIT
        XRA     A                   ; A=0
        MOV     M,A                 ; RESET SECONDS, CHECK MINUTES
        INX     H                   ; TO MINUTES
        MOV     A,M                 ; CURRENT
        ADI     1                   ; + 1
        DAA                         ; BCD CORRECTION
        MOV     M,A                 ; PUT IT BACK AGAIN
        CPI     060H                ; BCD FOR 60 MINUTES
        JNZ     CLK2                ; OK, EXIT
        XRA     A                   ; A=0
        MOV     M,A                 ; RESET MINUTES, DO HOURS
        INX     H                   ; TO HOURS
        MOV     A,M                 ; GET CURRENT
        ADI     1                   ; + 1
        DAA                         ; BCD CORRECTION
```

Listing 1 continued:

```
        MOV     M,A
        CPI     013H            ; OVERFLOW?
        JNZ     CLK2            ; OK
        MVI     M,001H          ; SET TO 1 HR
        INX     H               ; TO AM/PM FLAG
        MOV     A,M             ; GET CURRENT
        CMA                     ; REVERSE
        MOV     M,A             ; NEW
CLK2:   POP     H               ; RESTORE
        JMP     INTON1          ; DO ON/OFF CHECK

; THIS ROUTINE IS USED TO CHECK AND SEE IF THE
; INTERRUPTS SHOULD BE ON OR NOT, IT ENABLES THEM
; IF NECESSARY
;
;
INTON:  PUSH    PSW             ; SAVE
INTON1: LDA     ONOFF           ; GET FLAG
        ORA     A               ; AND TEST
        JZ      INTON2          ; OFF
        EI                      ; TURN ON
INTON2: POP     PSW             ; RESTORE USER
        RET
        ENDIF


; THIS COMPLETES THE CODE ADDED TO BIOS FOR CLOCK OPERATION
```

Text continued from page 482:
temporary disk so that any mistakes won't wipe out your good disk.

Now assemble the BIOS file. If you have any errors, be sure to correct them before continuing. When the program assembles correctly, you will have two files: CBIOSXX.PRN and CBIOSXX.HEX. Transfer these two files along with SYSGEN (the CP/M command file that initializes new disks), CPMXX.COM (the command file for changing system size—sometimes called MOVCPM.COM), BOOT.HEX (the source file for the cold-start loader program), and DDT. You are now ready to add the new BIOS to your system. The following sequence shows how:

A> DDT CPMXX.COM	(Call your file with DDT.)
DDT VERS X.X	
NEXT PC	
2100 0100	(system response after loading)
—	
—ICBIOSXX.HEX	(Input your CBIOS hex file.)
—RXXXX	(This number varies. Check your manual for correct offset bias.)
NEXT PC	(system response after loading CBIOS.HEX)
2286 0000	
—	
—IBOOTXX.HEX	(Input your BOOT hex file.)
—R900	(This offset number is always 900 for BOOT.)
NEXT PC	(system response after loading BOOT.HEX)
2286 0000	
—	
—^C	(Exit DDT with a warm boot.)
A>SYSGEN	(Call SYSGEN and follow the prompts on your terminal to complete initializing the new system.)

Now it's time to try the new system. Put in your new disk and cold boot. If all is well, your system should run normally. Be sure to check out the CP/M operating system thoroughly to make sure you haven't added a bug somewhere. If the system crashes, one way to get a cross-check is to print out the CBIOS.PRN file and compare it with your old listing. If the listings check, it is likely that you inserted some of the clock code in the wrong place. You'll have to do the BIOS over.

Once you get this far, the rest is easy. Call in your editor again and start a new file: TIME.ASM. This little program (listing 2) will reside permanently on your new

operating system disk. The coding is straightforward and heavily commented. After coding is complete, assemble the file and use the CP/M LOAD command to create the TIME.COM file on your new disk.

If you wired up the hardware on a kludge board, now is the time to install it. Power down and put in your board with the clock-disable switch OFF. Power up again and type the word "TIME" in response to the CP/M prompt. You can expect to see a garbled message, such as:

A> <d:'#:B> AM

If you get this answer—with strange characters for time—all is well. The time characters are just junk put in the time registers by the power-up start. "AM", "PM", or " : ", however, should appear in the proper position.

Now type in any valid 12-hour clock time. The display should read:

START CLOCK BY PRESSING RETURN

When you press return the display should read:

TIME IS SET TO = 12:00:00 PM (your set time)

If this message sequence doesn't occur, look for a problem in the TIME program. Fix this section before pro-

Text continued on page 492

Listing 2: *TIME, a program that initializes the clock in the CP/M command mode. It resides permanently on disk and, when called, sets, starts, and stops the clock and reads the time. TIME may be called from any drive.*

```
; CLOCK PROGRAM BY J. L. CALAWAY & B. HILL
; FEB 10, 1981  LISTING #2, 03:35:40 PM
; COMMUNICATIONS AREA EQUATES
;
BASE    EQU     040H            ; COMM. AREA
CLKADR  EQU     BASE            ; ADDR OF CLK IN BIOS
ONOFF   EQU     CLKADR+2        ; ON=1, OFF=0
SEC     EQU     ONOFF+1         ; BCD SEC
MIN     EQU     SEC+1           ; BCD MIN
HRS     EQU     MIN+1           ; BCD HOURS
AMPM    EQU     HRS+1           ; AM=0, PM=1
RSTLC   EQU     038H            ; RST-7

; CP/M ADDRESS EQUATES
;
ENTRY   EQU     00005H          ; DOS ENTRY
TAIL    EQU     00080H          ; COMMAND TAIL

; CP/M FUNCTION EQUATES
;
PMSG    EQU     009H            ; PRINT BUFFER
GCHR    EQU     001H            ; KEYBOARD

; ASCII EQUATES
;
CR      EQU     00DH            ; CARRIAGE RET
LF      EQU     00AH            ; LINE FEED
BELL    EQU     007H            ; BELL
EOM     EQU     024H            ; CP/M EOM

        ORG     0100H           ; CP/M TPA

; HERE WE BEGIN
;
START:  LXI     D,CRLF          ; CLEAR SCREEN
        MVI     C,PMSG
        CALL    ENTRY

; WHAT TO DO
; SHOW, SET, STOP
;
```

Listing 2 continued on page 488

Listing 2 continued:

```
        LDA     TAIL            ; COUNT
        ORA     A               ; TEST
        JZ      DISP            ; SHOW IF Ø
        LXI     D,TAIL+1        ; FIRST CHAR
        MOV     L,A             ; COUNT
        MVI     H,Ø
        DAD     D               ; END
        XRA     A               ; A=Ø
        MOV     M,A             ; EOF
; SCAN TO FIRST NON-BLANK CHAR
;
SCAN:   LDAX    D               ; CHAR
        ORA     A               ; EOM?
        RZ                      ; YES-SKIP
        CPI     ' '             ; SPACE?
        JNZ     SCAN1           ; NO
        INX     D
        JMP     SCAN

; NON-BLANK
;
SCAN1:  CPI     Ø61H            ; LOWER CASE
        JM      $+5             ; NO
        SBI     Ø2ØH            ; MAKE LOWER
        CPI     'S'             ; STOP
        JZ      STOP
; LOOKS LIKE WE WILL SET TIME
; CHECK TO SEE IF BIOS HAS CLOCK
;
        LHLD    CLKADR
        INX     H
        INX     H
        INX     H               ; TO ADDRESS
        MOV     C,M
        INX     H
        MOV     B,M
        LXI     H,NOT SEC-1
        DAD     B
        MOV     A,L
        ORA     H
        JZ      SCAN3
        LXI     D,BIOSMG
        MVI     C,PMSG
        CALL    ENTRY
        RET
; CONVERT INPUT TIME
;
SCAN3:  DCX     D               ; BACK UP POINTER

; TEST
; Ø-9 TIME
; :/M SKIP
; A/B SET AM/PM
; SPACE = SKIP
; ØØ = END
TEST:   INX     D               ; SRC
        LDAX    D               ; CHAR
        ORA     A               ; END?
```

Listing 2 continued:

```
        JZ      FINI
        CPI     Ø61H            ; LOWER
        JM      $+5
        SBI     Ø2ØH            ; CONVERT
        CPI     'Ø'             ; NUMBER?
        JC      TEST1           ; NO
        CPI     '9'+1
        JC      PACK            ; VALID
TEST1:  CPI     'A'             ; AM
        JZ      SETA
        CPI     'P'             ; PM
        JZ      SETP
        CPI     'M'             ; JUNK?
        JZ      TEST
        CPI     ':'             ; COLON
        JZ      TEST
        CPI     ' '             ; SPACE
        JZ      TEST
ERROR:  LXI     D,IVMSG         ; NG
        MVI     C,PMSG
        CALL    ENTRY
        RET

; PACK INTO BCD
;
PACK:   MVI     C,3             ; TO DO
        PUSH    D               ; SAVE
        LXI     H,BUFF+3
        LXI     D,BUFF+2
PACK1:  LDAX    D
        RAR
        RAR
        RAR
        RAR                     ; SHIFT NIBBLE
        ANI     ØØFH            ; CLEAR HIGH
        MOV     B,A             ; TEMP
        MOV     A,M
        RLC
        RLC
        RLC
        RLC                     ; SHIFT TO HIGH
        ANI     ØFØH            ; CLEAR LOW
        ORA     B               ; COMBINE
        MOV     M,A             ; SAVE
        DCX     D
        DCX     H
        DCR     C               ; DONE
        JNZ     PACK1
        POP     D               ; SRC
        LDAX    D               ; GET NEW
        ANI     ØØFH            ; TO BCD
        MOV     B,A             ; TEMP
        INX     H
        MOV     A,M
        ORA     B
        MOV     M,A
        JMP     TEST            ; NEXT
;
SETA:   XRA     A
```

Listing 2 continued on page 490

Listing 2 continued:

```
        JMP     SETAP
SETP:   MVI     A,ØFFH
SETAP:  STA     BUFF+4
        JMP     TEST            ; CONT

; FINISH
;
FINI:   LXI     H,TABLE         ; TIME CHK
        LXI     D,BUFF+1
        MVI     C,3
FINI1:  LDAX    D               ; GET TIME
        CMP     M
        JNC     ERROR
        INX     D
        INX     H
        DCR     C
        JNZ     FINI1
        DCX     D
        LDAX    D               ; MIN
        CPI     ØØ1H            ; BCD 1 HR
        JC      ERROR
        DI                      ; HOLD OFF
        LHLD    BUFF+1          ; COPY
        SHLD    SEC
        LHLD    BUFF+3
        SHLD    HRS
        LHLD    CLKADR          ; SET VECTOR
        SHLD    RSTLC+1
        MVI     A,ØC3H          ; JMP
        STA     RSTLC
        MVI     A,1
        STA     ONOFF           ; START
        LXI     D,STMSG         ; ASK FOR A START
        MVI     C,PMSG
        CALL    ENTRY
        MVI     C,GCHR
        CALL    ENTRY           ; GET KEY
        LXI     D,TIMSG         ; GIVE AN ANSYER
        MVI     C,PMSG
        CALL    ENTRY
        CALL    DISP            ; SHOW
        EI                      ; INTERRUPTS ON
        RET
; TABLE OF MAX. TIMES
;
TABLE:  DB      Ø6ØH,Ø6ØH,Ø13H

; STOP CLOCK
;
STOP:   DI                      ; INTERRUPTS OFF
        XRA     A               ; A=Ø
        STA     ONOFF           ; HALT
        LXI     D,STPMSG
        MVI     C,PMSG
        CALL    ENTRY           ; TELL WHEN
        CALL    DISP
        RET                     ; BACK TO CPM
; DISPLAY TIME 12HR FORMAT
;
```

Listing 2 continued:

```
DISP:
        LXI     H,HRS
        LXI     D,BUFF
        CALL    DTIM            ; SET UP
        LDA     AMPM            ; AM OR PM
        ORA     A               ; AM/PM
        MVI     A,'A'
        JZ      DISP1
        MVI     A,'P'
DISP1:  INX     D
        STAX    D
        LXI     D,BUFF
        MVI     C,PMSG
        CALL    ENTRY
        RET                     ; QUICK TO CP/M

; DISPLAY TIME
;
DTIM:   MVI     C,3             ; TO DO
DTIM1:  MOV     A,M             ; GET DATA
        RAR                     ; ISOLATE HI NIBBLE
        RAR
        RAR
        RAR                     ; MSN
        ANI     ØØFH            ; CLEAR
        ORI     'Ø'             ; TO ASCII
        STAX    D               ; STORE IN BUFFER
        INX     D
        MOV     A,M             ; LOW NIBBLE
        ANI     ØØFH
        ORI     'Ø'
        STAX    D
        DCX     H
        INX     D
        DCR     C               ; DONE
        RZ
        MVI     A,':'           ; ADD COLON
        STAX    D
        INX     D
        JP      DTIM1
; DATA AND MESSAGE AREA
;
BIOSMG: DB      BELL,'NO CLOCK IN BIOS',CR,LF,EOM
IVMSG:  DB      BELL,'INVALID TIME',CR,LF,EOM
STPMSG: DB      'STOPPED AT ',EOM
STMSG:  DB      'START CLOCK BY PRESSING RETURN ',EOM
TIMSG:  DB      CR,LF,'TIME SET TO = ',EOM
BUFF:   DW      Ø               ; DISPLAY DATA
        DW      Ø
        DW      Ø
        DW      Ø
        DB      ' AM'
CRLF:   DB      CR,LF
CRLF1:  DB      CR,LF,EOM
        DS      32              ; ROOM
STACK   EQU     $

;
        END
```

Text continued from page 487:

ceeding.

Now again type "TIME" in response to the prompt and the display should read:

A> 12:00:00 PM

At this point you should have a working clock. Turn on the disable switch in your clock board and go through the set-time sequence again. There should be a time change in the seconds column whenever you type "TIME" in response to the CP/M prompt.

Check out the minutes and seconds registers by setting the clock to 12:59:50. In 10 seconds, it should make the change to 01:00:00. If it does, congratulations! You now have a time-of-day clock—just like the expensive mainframe computers. If you have problems, then double-check your steps. This program has been thoroughly tested and should work.

If you program in BASIC, include one or two of the BASIC subroutines (listings 3, 4, and 5) in your programs. You will then be able to get a time readout whenever you want by simply calling one of these subroutines.

Note that there are two listings for reading the clock. Listing 3 is a program in Microsoft BASIC with the instruction HEX$(X). Not all BASICs have this instruction, so there is an alternate clock read (listing 4), which does the same thing but less elegantly.

An interesting note here about the way that the HEX$(X) instruction works: remember that the program stores the clock as a binary-coded-decimal number. For example, 25 seconds would be stored in the register as 0010/0101. The 2 is stored in the upper 4 bits and the 5 in the lower 4 bits. Due to the binary weighting of the 8 bits in the register, the HEX$(X) instruction sees what it thinks is decimal 37. When called, the instruction dutifully returns the hexadecimal value of this number, or 25. Furthermore, it gives us that value as **a** string. Just what we need! Sneaky, isn't it? And very useful in cutting code down to size and setting up a printout.

Listing 5 is a short BASIC program that enables you to

Listing 3: *A clock-read program in Microsoft BASIC. It can be used as a subroutine in a larger program to allow reading the clock when desired. This program makes interesting use of the HEX$(X) instruction.*

```
10 REM  CLOCK PROGRAM BY J.L. CALAWAY & B. HILL
20 REM  FEB 12, 1981   02:20:47 PM   LISTING #3
30 REM
40 REM   READ CLOCK PROGRAM FOR BASIC WITH  HEX$(X) COMMAND
50 REM
60 REM------------------READ THE REGISTERS-------------------------
70 REM
80      T(1)=PEEK(69):T(2)=PEEK(68):T(3)=PEEK(67):M1=PEEK(70)
90      IF M1=0 THEN M1$="AM" ELSE M1$="PM"
100 REM
110 REM-----LOOP TO CHANGE REGISTER VALUES TO DECIMAL STRINGS---------
120 REM
130      FOR I=1 TO 3
140        IF VAL(HEX$(T(I)))<10 THEN T$(I)="0"+HEX$(T(I))
                 ELSE T$(I)=HEX$(T(I))
150      NEXT I
160 REM
170 REM-------------------------PRINT IT-----------------------------
180 REM
190      PRINT "TIME:  ";T$(1);":";T$(2);":"T$(3);" ";M1$
200 REM
210 REM-----------------STORE AND/OR RETURN---------------------------
```

Listing 4: *A clock-read program for users who have a version of BASIC without a HEX$(X) instruction. It works the same as listing 3, but takes twice as much code. It assumes that DIM(X) need not be used if X is less than 10.*

```
100  REM  CLOCK PROGRAM BY J. L. CALAWAY AND B. HILL
110  REM  FEB 12, 1981   03:05:19 PM     LISTING #4
120 REM
130 REM   READ CLOCK PROGRAM FOR BASIC WITHOUT THE HEX$(X) COMMAND
140 REM
150 REM---------------------READ THE REGISTERS-----------------------
160 REM
170     T(1)=PEEK(69):T(2)=PEEK(68):T(3)=PEEK(67):M1=PEEK(70)
```

Listing 4 continued:

```
180     IF M1=0 THEN M1$="AM" ELSE M1$="PM"
190 REM
200 REM-----------LOOP CHANGES HEX CODE TO DECIMAL STRINGS-------------
210 REM
220     FOR I= 1 TO 3
230        X=T(I)
240        X=X-16
250      IF X<0 THEN GOTO 290
260         IF X<10 THEN T(I)=T(I)-6
270            IF X>10 THEN T(I)=T(I)-6: GOTO 240
280 REM
290       IF T(I)<10 THEN T$(I)="0"+RIGHT$(STR$(T(I)),1)
            ELSE T$(I)=RIGHT$(STR$(T(I)),2)
300     NEXT I
310 REM
320 REM--------------------PRINT THE STRINGS---------------------------
330 REM
340      PRINT T$(1)":";T$(2);":";T$(3);" "; M1$
350 REM
360 REM-----------------STORE AND/OR RETURN AS DESIRED-----------------
```

Listing 5: *A BASIC program to set the clock by jamming a time into the clock registers. The clock has previously been started in the CP/M command mode and is running continuously. The program makes a cursory check for valid entries; an exhaustive examination for invalid time would require more code. The clock cannot be stopped and started from a BASIC program.*

```
200 REM  CLOCK PROGRAM BY J. L. CALAWAY & B. HILL
210 REM  FEB 12, 1981   02:23:07 PM  LISTING 5
220 REM
225 REM  BASIC PROGRAM TO SET TIME IN RUNNING CLOCK
230 REM
240     LINE INPUT "WHAT TIME DO YOU WANT SET (HHMMSS(AM OR PM)"; T$
250       IF LEN(T$)<>8 THEN PRINT CHR$(7); "INVALID TIME": GOTO 240
260 REM
270 T(1)=VAL(MID$(T$,5,2)): T(2)=VAL(MID$(T$,3,2)): T(3)=VAL(LEFT$(T$,2))
280       IF MID$(T$,7,2)="AM" THEN T(4)=0 ELSE T(4)=1
290 REM
300 REM-----------LOOP TO CHANGE SET TIME TO BCD-------------------------
310 REM
320       FOR I=1 TO 4
330         X=T(I)
340         X=X-10
350           IF X<0 THEN 380
360             IF X<=9 THEN T(I)=T(I)+6
370               IF X>9 THEN T(I)=T(I)+6: GOTO 340
380          POKE 66+I,0+T(I)
390        NEXT I
400 REM
410 REM-----------PRINT/STORE OR RETURN AS DESIRED-----------------------
```

set the clock from BASIC. But this program doesn't start or stop the clock. The time code is simply jammed into the running clock registers.

Depending on your variety of BASIC, you may have to make a few more changes in the code. If you use CBASIC, for example, then you will have to add DIM statements to initialize the arrays. Or you could forget the arrays and simply use separate variables for the hours, minutes, seconds, and the AM/PM registers. If your BASIC requires the DIM statement, you may also have to initialize the arrays to 0.

While the BASIC listings serve as a starting point, you can embroider them as you wish. Maybe you would like to store the time in registers to be printed back later in the program. Perhaps you would like to display the seconds ticking away to add a sense of pressure to a favorite game program. Now that you have a clock, you can easily do such tricks. We hope you enjoy it.■

What's New?

SYSTEMS

Ace 100

Franklin Computer Corp. claims that its Ace 100 personal computer is 100% hardware- and software-compatible with the Apple computer. According to the company, all programs written for the Apple II, including high- and low-resolution black-and-white graphics, will run on the Ace without modification. Standard features include 64K bytes of RAM (random-access read/write memory) and a Videx Keyboard Enhancer. The Ace has an uppercase and lowercase 72-key typewriter-like keyboard and a 12-key numeric keypad

The Franklin Ace 100 is available for $1595. Contact Franklin Computer Corp., 7030 Colonial Highway, Pennsauken, NJ 08109, (609) 488-1700.

Circle 500 on inquiry card.

Expandable Pocket Computer

The Model PC-2 TRS-80 Pocket Computer features a BASIC interpreter with 42 statements, 34 functions, and 6 commands. The expandable PC-2 has full string-handling abilities with 80-character string length and two-dimensional arrays, a 26-character alphanumeric LCD (liquid-crystal display) with uppercase and lowercase characters, 2.5K bytes of memory, and a built-in real-time clock. Additional features include fully addressable 7 by 156 dot-matrix LCD graphics and a 60-pin I/O interface connector

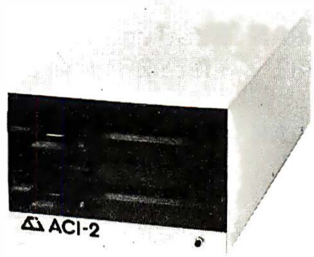
Options for the PC-2 include an RS-232C interface and software, a four-color printer/plotter with nine different character sizes, and add-on RAM (random-access read/write memory) and ROM (read-only memory) modules. The PC-2 costs $279.95. A 4K-byte memory module is available for $69.95. Contact local Radio Shack stores, computer centers, and participating dealers, or the Tandy Corp., 1300 One Tandy Center, Fort Worth, TX 76102.

Circle 501 on inquiry card.

Wicat System 150

The high-capacity Wicat System 150 includes an 8-MHz Motorola 68000 microprocessor (a 16-bit processor), memory, display screen, storage, and storage backup in a single desktop unit. The 150's main memory ranges from 256K bytes to 1.5 megabytes; standard mass storage includes a 10-megabyte Winchester hard-disk drive and a 960K-byte 5¼-inch floppy-disk drive for backup. The single-user, real-time, multitasking 150 can be configured with 5¼-inch floppy disks or as an intelligent terminal without mass storage. The System 150 supports two RS-232C serial interfaces, a 16-bit parallel interface, and Pascal, C, APL, Ada, COBOL, FORTRAN, LISP, WBASIC, and 68000 assembly languages.

Hardware options include a videodisc interface and a battery backup. Optional operating systems include Unix version 7 and a CP/M emulator. The Wicat System 150 ranges in price from under $4000 for the intelligent terminal to $8500 with the Winchester hard-disk unit. Contact Wicat Systems, 1875 South State St., Orem, UT 84057, (801) 224-6400.



Desktop Computer

The ACI-2 desktop computer features two high-performance 8-inch floppy-disk drives and 64K bytes of RAM (random-access read/write memory). The Z80-based ACI-2 can run Digital Research's CP/M 2.2 software and interface with most industry-standard terminals, modems, and printers through three RS-232C serial ports. The ACI-2, which can be used with a modem for communications over telephone lines and as a smart timeshare terminal, is available for $2995 from Alspa Computer Inc., 300 Harvey West Blvd., Santa Cruz, CA 95060, (408) 429-6000.

Circle 503 on inquiry card.

PUBLICATIONS

Konan Products Catalog

Hard-disk drives and controllers, I/O controllers, cables, power supplies, and other items are listed in a free catalog of Konan products. Contact Konan Corp., 1448 North 27th Ave., Phoenix, AZ 85009, (800) 528-4563; in Arizona, (602) 269-2649.

Circle 504 on inquiry card.

Understand Your VIC

Understanding Your VIC, Volume 1: Basic Programming is a step-by-step guide to learning about your Commodore VIC-20. Many of the book's exercises give the correct results so that you have feedback at your fingertips. The VIC's color and sound abilities can be mastered with the help of chapters that show you how to build demonstration programs with these features. Another chapter describes how the proper use of psuedocode and data dictionaries can help you refine programming problems.

Available in softcover for $11.95, **Understanding Your VIC, Volume 1** can be purchased from Commodore dealers or directly from Total Information Services, POB 921, Los Alamos, NM 87544, (505) 455-7049.

Circle 505 on inquiry card.

What's New?

8088 User's Manual

Intel's **iAPX 88 Book** details the 8088's architecture and discuss its 8- and 16-bit registers, megabyte memory-addressing modes, and instruction set. An overview of the 8088's key features, addressing techniques, and functional extensions is provided. A separate hardware section covers bus timing and interface considerations, interrupt handling, direct memory addressing, and interfacing memory and peripherals. Examples are given of multiplexed- and demultiplexed-bus personal and small-business computers, an S-100-bus-based design, and an 8088-based video-display controller.

The iAPX 88 Book costs $7.50. Contact Intel Corp., Literature Dept., 3065 Bowers Ave., Santa Clara, CA 95051, (408) 734-8102.
Circle 506 on inquiry card.

Microprocessor Operating Systems

Microprocessor Operating Systems provides in-depth descriptions of National Semiconductor's BLMX-80, Intel's iRMX 80/88 and iRMX 86, Data General's MP/OS, Texas Instruments' Rx, Bell Lab's Unix, Motorola's VERSAdos, and Zilog's RIO/CP and ZRTS operating systems. The book is available for $11.95 from Microcomputer Applications, POB E, Suisun City, CA 94585, (707) 422-1465.
Circle 507 on inquiry card.

Software Business Review

ICP Software Business Review analyzes software solutions to business problems for the corporate and data-processing executive. Existing and potential information-management problems are identified, and software solutions are proposed. Contact International Computer Programs, 9000 Keystone Crossing, Indianapolis, IN 46240, (800) 428-6179; in Indiana, (317) 844-7461.
Circle 508 on inquiry card.

TI Logo Source

Microcomputers Corporation has a new catalog and a newsletter for Texas Instruments' TI-99/4A computer users. The bimonthly **TI Logo Source** newsletter is filled with reviews and news of the latest developments in Logo software. The catalog is packed with lists of available Logo programs. Both are free from Microcomputers Corp., POB 191, Rye, NY 10580, (914) 967-8370.
Circle 509 on inquiry card.

Data Manual

The design and operation of the OB68K1 single-board computer are described in a data manual available from Omnibyte. The OB68K1 computer system features the Motorola 16-bit MC68000 microprocessor on a Multibus/IEEE P796 bus and software compatibility with Motorola's MEX678KDM. The manual is available for $10 from Omnibyte Corp., 245 West Roosevelt Rd., West Chicago, IL 60185, (312) 231-6880.
Circle 510 on inquiry card.

Microcomputer Buyer's Guide

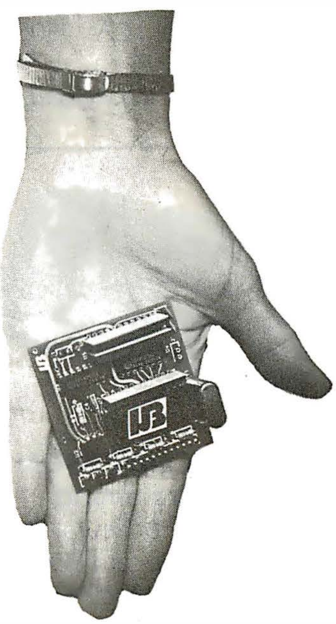
Webster's Microcomputer Buyer's Guide reviews more than 150 microcomputer systems from more than 50 suppliers. Individual chapters elaborate on the general topics of theory, applications, independent software vendors, and a wide range of display and printing terminals. The guide costs $25, plus $2.50 postage and handling. Contact Computer Reference Guide, 135 South Harper Ave., Los Angeles, CA 90048, (213) 852-4886.
Circle 511 on inquiry card.

CP/M Users Software Directory

Vital Information's CP/M software directory is designed to aid hobbyists in the selection of software and peripherals. The directory contains more than 3000 entries, divided into 33 sections by subject. Program entries include publisher and list price. A toll-free hotline is available for subscribers who have software, hardware, or peripheral questions.

The directory costs $19.95, plus $1.50 postage. Contact Vital Information Inc., 7899 Mastin Dr., Overland Park, KS 66204, (800) 255-5119; in Kansas, (913) 381-1818.
Circle 512 on inquiry card.

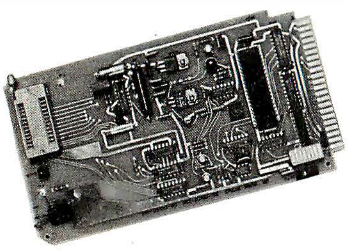
PERIPHERALS



Hide Your Modem

The MB10303 is a compact Bell-compatible 300-bit-per-second (bps) modem intended for space-saving applications. It measures 5.8 by 5.75 by 2 cm (2$\frac{5}{16}$ by 2$\frac{1}{4}$ by $\frac{3}{4}$ inches) and requires 33.5 square cm (5$\frac{1}{5}$ square inches) of circuit-board area. It operates in full-duplex, manual originate, and manual or automatic answer. It interfaces at standard transistor-transistor logic (TTL) levels. Power requirements are 40 milliamperes (mA) at +5 volts (V) DC, 25 mA at +8 to +18 V DC, and 25 mA at −5 to −12 V DC. It can

communicate with Bell System 103 and 113 series modems, with Bell 212A and Vadic 3400 series modems operating in the low-speed (300 bps) mode, and with acoustic-coupler data sets that use complementary signaling and handshake sequences. For further information, contact Micro-Baud Systems Inc., 3393 De La Cruz Blvd., Santa Clara, CA 95050, (408) 727-5275.
Circle 513 on inquiry card.



Single-Card EPROM Programming

Giddings & Lewis Electronics' single-card EPROM Programmer Module is designed to program 2708 EPROMs (erasable programmable read-only memories). It doesn't require a special software-development system because it plugs directly into your production system. The module fits into a standard 114-millimeter- (4½-inch-) wide nest. The easy-to-use Programmer pulses each EPROM 100 times per byte; total programming time is 100 seconds per kilobyte of memory.

The EPROM Programmer Module costs $295. Contact Giddings & Lewis Electronics, 142 Doty St., POB 590, Fond du Lac, WI 54935, (414) 921-9400.
Circle 514 on inquiry card.



KIM-Compatible Mini-Disk Systems

Percom Data Company's MFD mini-disk storage systems for AIM-65, KIM, and SYM computers are available in one-, two-, and three-drive versions. The MFD systems are available in 40- and 80-track models and in both standard- and "flippy-" drive versions. The 40-track drive can store 102K bytes of formatted data; the 80-track drive stores 205K bytes.

An MFD system includes a disk-controller circuit card, a disk operating system (DOS) in ROM and on a disk, an interconnecting cable, user's manual, and disk drives. Two controllers are available: one for the AIM-65, the other for Percom's System-50 (SS-50) bus. Utilities and a 20-command library are supplied on the system disk. The DOS communicates directly with an Aim Monitor, Editor, BASIC, or other AIM program through your I/O and F1 and F2 keys.

The Percom MFD drive systems start at $599.95. An interface for connecting the drives to your computer costs $49.95. Contact Percom Data Co., 211 North Kirby, Garland, TX 75042, (214) 272-3421.
Circle 515 on inquiry card.

Paddle-Adapple

The Paddle-Adapple I/O expansion adapter lets software writers create four-player games with each player having paddle and push-button controls. Paddle-Adapple plugs into the Apple II's game port and works in two modes: the first lets you select between two devices plugged into the Apple; the second takes advantage of the Apple's ability to handle up to four game controllers. In either mode, the Paddle-Adapple's "jumper" sockets can be configured to meet designer needs, such as exchanging X and Y axes or reassigning push-button numbers.

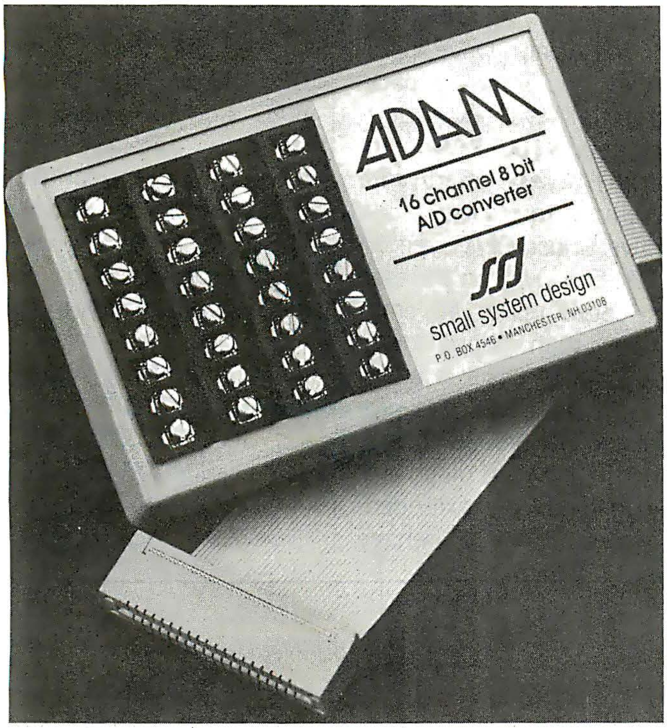
The Paddle-Adapple is compatible with all Apple software and with most game I/O devices. The shift-key modification is supported. It costs $29.95 and is available from Southern California Research Group, POB 2231-B, Goleta, CA 93118, (805) 685-1931.
Circle 516 on inquiry card.

Clock/Calendar Board

Columbus Instruments' IB-902AB interface card converts the AIM-65, PET, KIM, 6502, and 6800 computers into dedicated laboratory and industrial measurement systems. It contains a 12-bit A/D (analog-to-digital) converter, a 16-channel multiplexer, a real-time clock/calendar with battery backup, and space for an additional 16K bytes of memory. The clock/calendar is crystal-controlled to three seconds per month and provides time in seconds, minutes, hours, day of week, date, month, and year. A 12- or 24-hour clock is selectable, and programmable interrupts from 1024 per second to 1 per second are available. The onboard battery backup will provide the accurate time of day for up to four years. Conversion time of the A/D converter is 35 microseconds. Power requirements are ± 15 volts.

Supplied with demonstration programs for setting up the clock/calendar, reading analog channels, and addressing and testing memory, the IB-902AB costs $1270. Contact Columbus Instruments, 950 North Hague Ave., Columbus, OH 43204, (614) 488-6176.
Circle 517 on inquiry card.

What's New?



Adam Family

The Adam family of add-on modules are designed to bring mini- and microcomputers into the world of data acquisition. The modules accept up to 16 analog inputs from a wide variety of analog devices and transducers such as temperature, flow-rate, and current sensors. The modules convert input voltage to digital values with a resolution of 8 bits.

Adam modules are available with either an interface for the TRS-80 Expansion Interface or with an RS-232C asynchronous interface. The TRS-80 version costs $190; the RS-232C interface is $250. For details, contact Small System Design, POB 4546, Manchester, NH 03108, (603) 432-7929.

Circle 518 on inquiry card.

5-Megabyte Memory System

The LS525, a 5-megabyte memory system, incorporates a Seagate ST506 5¼-inch Winchester hard-disk drive, Logical Systems' LDOS disk operating system, a linear power supply, and the LSI 500 series controller. A separate host adapter provides cross-connections to different central processors and buses. All TRS-80 programs currently running under TRSDOS or NEWDOS will operate with LDOS.

The LS525 costs $3750, including a manual that details LDOS operations. Contact Laredo Systems Inc., 2264 Calle de Luna, Santa Clara, CA 95050, (408) 980-1888.

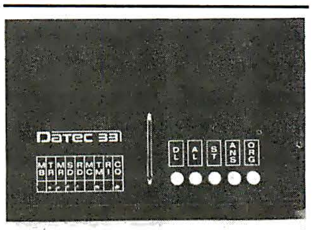
Circle 519 on inquiry card.

To Alphasyntauri and Bach

The Alphasyntauri synthesizer is a modular instrument system that uses computer programs rather than hard-wired components to create and control sounds. Based on the Apple II microcomputer, the Alphasyntauri gives musicians an all-digital instrument that doesn't require programming or computer expertise.

An Alphasyntauri music system is made up of the Alphaplus operating system, instrument definitions, software utilities, a 61-note keyboard, foot pedals, and a computer interface. Mountain Computer's Musicsystem synthesizer provides 8-voice stereo polyphony. The complete system, including the Apple II, costs $5000. The instrument alone costs $2100. The Alphasyntauri is available from selected Apple dealers. A demonstration record costs $2. Contact Syntauri Corp., 3506 Waverly St., Palo Alto, CA 94306, (415) 494-1017.

Circle 520 on inquiry card.



Bell-Compatible Modem

The Datec 33 is a 0- to 300-bit-per-second (bps) Bell-compatible originate/answer modem featuring a front panel voice/data button, long space disconnect, five diagnostic tests, and built-in "A" control. The modular-designed rack-mountable modem will operate with any telephone over dial networks or over two-wire leased lines. The computer-to-terminal interface is a standard RS-232C connection.

The Datec 33 has a suggested retail price of $399 in a stand-alone version and $325 for a card model. Contact Datec Inc., 300 East Main St., Carrboro, NC 27510, (919) 929-2135.

Circle 521 on inquiry card.

Joystick Interface

Joy-6 is a joystick interface for TRS-80 Models I and III that features push buttons, sound-effects capability, and control software. It can be used as a 6-channel analog-to-digital converter with temperature sensors or other transducers, and it can drive an external relay for control applications.

A complete Joy-6 package includes two joysticks with push buttons, power supply, user's manual, and the Joypak-1, a 16K-byte machine-language cassette packed with six joystick games. The Model III version requires an adapter cable. Joy-6 costs $124.95; a kit version is available for $99.95. Contact Mega Systems Inc., 262 Park Lane, King of Prussia, PA 19406, (215) 337-3876.

Circle 522 on inquiry card.

What's New?



New Products from Commsoft

Commsoft's CW89 software package lets ham-radio operators send and receive Morse code with their Heath H-8/H-19 or Heath/Zenith Z-89 microcomputers. The CW89 features a split-screen display, 4- to 99-word-per-minute operation, the ability to receive autotrack, a 1000-character pretype buffer, ten user-definable messages, a break-in mode, on-screen system status, disk I/O, hard-copy capabilities, and a code-practice section. All communications can be sent to a printer or stored on a disk. The CW89, which requires a hardware interface such as Commsoft's Codem, is available for $99.95, postpaid.

The Codem interface is a universal continuous-wave (CW) interface that converts received CW audio into RS-232C or TTL signal levels and RS-232C or TTL signal levels to transmitter keying, so the Codem doubles as a code-practice oscillator and CW regenerator. The Codem costs $124.95; a 9-volt DC power supply is $9.95. A complete package consisting of the software, Codem, an interface cable, power supply, documentation, and shipping fees is available for $249.95. Contact Commsoft, 665 Maybell Ave., Palo Alto, CA 94306, (415) 493-2184.

Circle 523 on inquiry card.

Modem Plus

The Modem-Plus is a 1200-bit-per-second (bps) 202C/S-compatible modem for the S-100 bus. The address-selectable, originate/answer modem provides S-100 interface requirements, an on-board modem UART (universal asynchronous receiver/transmitter) with selectable word format, hardware-automatic pulse-dialing, 16-digit memory for redial, and modem sense and control lines using polling methods. Registered with the FCC for direct connection to the telephone system, the Modem-Plus is available in two models: one has a second on-board UART with selectable word format connected to a separate RS-232C I/O port; the other provides modem interrupts to the processor rather than the RS-232C port. The Modem-Plus is available for $595 from Integrated Design Engineering Inc., POB 16307, St. Louis, MO 63125, (314) 487-1188.

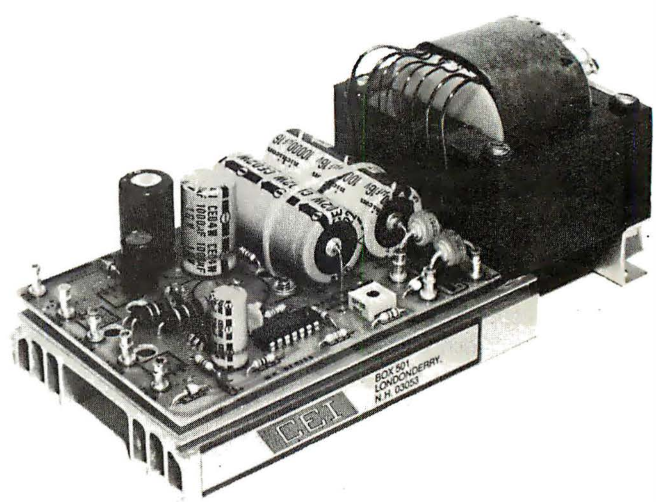
Circle 524 on inquiry card.

Get Into Warp Drive

The Warp Drive hardware and software package allows extended-address S-100 RAM (random access read/write memory) to emulate a disk drive under CP/M version 2.2, providing an increase in speed up to 40 times faster than floppy disks. The Warp Drive is based on Compupro's dual-processor 8085/8088 board, which allows as much as 1 megabyte of extended-address RAM to behave like a disk drive under CP/M-80 on the 8-MHz 8085 and to appear as directly addressable memory when running CP/M-86 on the 8-MHz 8088. All CP/M 2.2-compatible software runs on the Warp Drive without modifications.

The Warp Drive is available from G & G Engineering, 13708 Doolittle Dr., San Leandro, CA 94577, (415) 895-0798.

Circle 525 on inquiry card.



Multiple-Output Power Supply

The Model MP400 Power Supply can drive small line printers and low-current floppy-disk drives. It provides outputs of +5 volts (V) DC at 5 amperes (A) with overvoltage protection, +12 V DC at 0.5 A, −5 V DC at 0.5 A, and +24 V DC at 0.75 A with a 1.2-A surge capability. The +5-V DC output is regulated to 0.1%; all others to 5%. Noise and ripple are less than 10 millivolts. The MP400 fits into standard slope-front microprocessor enclosures and requires either 115 or 230 V AC ± 10% input power. An aluminum heat sink maintains low ambient temperatures. The MP400 Power Supply costs $72 in original-equipment-manufacturer quantities and is available from CEI Corp., Grenier Industrial Park, POB 501, Londonderry, NH 03053, (603) 623-8888.

Circle 526 on inquiry card.

What's New?

Microspeed

Apple II, II Plus, and III users can realize processing speeds up to 100 times faster than Applesoft BASIC with the Microspeed Language System. Developed from an extended FORTH, Microspeed is a hardware and software package that uses the Intel 8231A arithmetic processor and interactive compiler to provide enhanced programming capabilities such as print formatting, fast high-resolution and "turtle" graphics, and extended, high-speed mathematical functions.

System utilities include line- and screen-oriented text editors and a 6502 assembler. Each Microspeed comes with an auxiliary processor card, a user's manual, and two disks of software.

Two Microspeed configurations are available: Microspeed II, which uses a 2-MHz 8231A arithmetic processor, and Microspeed II+, which uses the newer 4-MHz 8231A. Microspeed II costs $495, Microspeed II+ costs $645. The manual is available separately for $35. Contact Applied Analytics Inc., Suite 200, 8910 Brookridge Dr., Upper Marlboro, MD 20772, (301) 627-6650.

Circle 527 on inquiry card.

Mice In Your System

Upgrade your microcomputer to a development tool with MICE—Micro In-Circuit Emulator. A dual-processor, two-board device with a built-in line assembler and a two-pass disassembler, MICE features real-time emulation up to 5 MHz and an RS-232C interface for modems or terminals with data rates from 110 to 9600 bits per second.

MICE is available for 8085A, Z80, Z80A, Z80B, 6502, NSC800, 8048, 8049, and 8050 microcomputers. Prices range from $1495 to $5000. Obtain additional details from Microtek Lab Inc., 17221 South Western Ave., Gardena, CA 90247, (213) 538-5369.

Circle 528 on inquiry card.

Hollister Microsystems

Hollister Microsystems supplies interface boards, peripheral devices, and software for the Apple II, the IBM Personal Computer, and other microcomputers. For the Apple II, Hollister offers a 6800 cross-assembler on disk and an EPROM- (erasable programmable read-only memory) programmer/EPROM card for programming 2716, 2732, 2732A, and 2764 EPROMs. Other products for the Apple include an EPROM/ROM simulator and a 24-bit parallel I/O card with high-level-drive and master/slave stacking capabilities.

For complete details on these and other products, contact Hollister Microsystems, 5081 Fairview, Hollister, CA 95023, (408) 637-0753.

Circle 529 on inquiry card.



No More Waiting

If you're tired of waiting for your printer, plotter, or other peripheral to finish its job so you can get back to your computer, the Microcue may be what you've been waiting for. Microcue, a programmable Z80-based first-in, first-out (FIFO) device, accepts data from your computer and drives the printer from its own memory, freeing the host computer for other chores. A multiport Microcue can connect multiple printers and computers and select between them from switches or software control. The Microcue SP has serial and parallel ports and can convert from one to the other.

In addition to buffering, all Microcues are download-programmable, which allows for poll and select, code conversions, data formatting, modem operation, and interfacing to other systems. Present models have from two to eight ports and 16K to 32K bytes of memory. Prices start at $299. Contact Microcompatible, POB 7624, Atlanta, GA 30357, (404) 874-8366.

Circle 530 on inquiry card.

Apple Cat II

The Apple-Cat II is a large-scale integration (LSI) modem that converts your Apple II or II Plus computer into a functional telephone, complete with a handset. It can automatically answer, dial, re-dial, and disconnect a telephone call. Both Baudot and ASCII code are combined in this single add-on product. For the deaf and hearing impaired, a special 45.5-bit-per-second (bps) Baudot-coded Weitbrecht modem is provided for use with teletypewriters (TTYs).

Data-transmission rates range from 50 to 1200 bps. Software is supplied on a floppy disk. A separate RS-232C serial port is provided, and the Apple Cat II also offers a 26K-byte memory-storage area and software controls that assure the accurate transmission of data.

An optional program chip provides compatibility

with many languages and operating systems, including BASIC, Pascal, and CP/M. The Apple-Cat II costs $389 and is available from authorized Novation distributors. Contact Novation Inc., 18664 Oxnard St., Tarzana, CA 91356, (213) 996-5060.
Circle 531 on inquiry card.

80-Column PET Adapter

Execom's 80-column adapter, circuit board, and ROM combination lets you switch the Commodore PET's 40-column display to an 80-column display from the keyboard or through program control. The kit contains a dual 24-pin socket, a circuit board that replaces the existing screen programmable memory, and an 80-column reference ROM that plugs into an expansion slot.

The circuit board and ROM combination is designed for the 2000, 3000, and 4000 series of PET/CBM computers that are designed for version 3.0 or 4.0 BASIC but do not have a video-display or a display-controller chip. The kit costs $275; Execom will install the adapter for an additional $75. An optional board that allows the ROM to be used with any other 2K-byte ROM in any expansion socket is available for $25. For details, contact Execom Corp., 1901 Polaris Ave., Racine, WI 53404, (414) 632-1004.
Circle 532 on inquiry card.

Z65: Database Processor

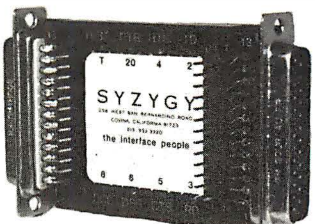
The Z65 Database Processor is an applications development tool for the Apple II. It consists of a Z80 microprocessor, a 6502-to-Z80 software interface, and a Z80 implementation of the MDBS database-management program, which is based on an extended-network data model. With the Z65, all applications development is performed within the Apple disk operating system using Applesoft BASIC. Database manipulations are handled by the Z80, which increases the 6502's speed.

With documentation, the Z65 package is available through a single-user license for $1600. Without the Z80 card, the Z65 software costs $1500, including documentation. Manuals can be purchased separately. For details, contact Micro Data Base Systems Inc., POB 248, Lafayette, IN 47902, (317) 448-1616.
Circle 533 on inquiry card.

MISCELLANEOUS

Video Attributes Controller

The CRT 8021 Video Attributes Controller (VAC) works in conjunction with a character-generator ROM to provide video attributes and graphics for a display screen. An n-channel MOS/LSI (metal-oxide semiconductor/large-scale integrated) circuit, the 8021 processes and serializes parallel data from the character generator for direct connection to the video input of a display-screen monitor. Attributes are added to alphanumeric data as you choose. The 8021 features both field and character attributes graphics modes, a 20-MHz video shift register, cursor, and separate data and attributes latches. Attributes include reverse video, character blink and blank, underline, and strike through. For more details, contact Standard Microsystems Corp., 35 Marcus Blvd., Hauppauge, NY 11787, (516) 273-3100.
Circle 534 on inquiry card.



Patch Set Monitors Line Signals

Syzygy's RS-232 Patch Set is a handheld device that connects inline with an interface cable, terminal, or modem. Designed for engineers and field-service personnel working with custom or nonstandard interfaces, the Patch Set's two 26-pin headers and jumpers permit line monitoring and full configuration of all 25 line signals. This lets the user completely define the configuration by means of jumper cables. The unit does not affect communications and is transparent to the line.

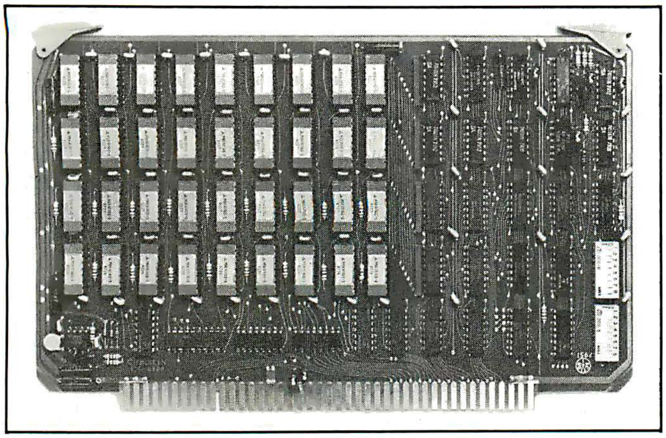
About the size of a business card, the Patch Set conforms to RS-232C standards and comes with ten 2-pin, four 3-pin, and one 4-pin jumper assemblies. The RS-232 Patch Set costs $111. Contact Syzygy, 256 West San Bernardino Rd., Covina, CA 91723 (213) 332-3320.
Circle 535 on inquiry card.

Flipper Flips Signals

A software-controllable switch that lets you switch voltage signals with simple software commands, the Flipper can be used between alternate video signals such as those generated by the Apple and an 80-column video board. The device plugs into the game port on the Apple and makes use of annunciator output zero (AN0). It allows unobstructed use of all the remaining functions for game I/O by providing a parallel game I/O connector.

The Flipper has two RCA phono jacks for input and one for output, and it can be arranged to have one jack for input and two for output. The board drains 30 milliamperes when the relay is energized. The Flipper costs $50 and is available from Aurora Systems Inc., 2040 East Washington Ave., Madison, WI 53704, (608) 249-5875.
Circle 536 on inquiry card.

What's New?



Dynamic Memory Board

The CI-6800-2 dynamic-memory board for the Exorcisor I and II and Rockwell International's System 65 plugs directly into existing Exorcisor connectors. Available in 16K-, 48K-, and 64 K-byte configurations, the board allows maximum processor throughput with the use of hidden-refresh control logic onboard. Data-access time is 225 nanoseconds (ns) and cycle time is 400 ns, which allows the board to operate as a static programmable memory at clock rates in excess of 1.5 MHz. For 2-MHz operation, the board can be configured to use a cycle-stealing refresh operation.

Onboard memory-select is available in 4K-byte increments to up to 64K bytes of memory. Another feature is onboard even parity with output jumper-selectable to the system bus as a parity error or nonmaskable interrupt. The board's power consumption is under 7 watts.

Prices range from $475 for the 16K-byte by 8-bit version to $575 for the 64K-byte by 8-bit version. Contact Chrislin Industries Inc., 31352 Via Colinas #102, Westlake Village, CA 91361, (213) 991-2254.

Circle 537 on inquiry card.

Remote Transmitter Controls Appliances

The BSR System X-10 Model TR274 remote telephone transmitter is a portable, calculator-size transmitter that is used in conjunction with a personal computer and your telephone. With the TR274, you can control any lights and appliances that are hooked up to your base station from any telephone, anywhere. The TR274 works with answering machines as well. The transmitter must be used with the TR270 telephone responder/controller. The Model TR274 telephone transmitter costs $29.99. As a set, the TR274 and the TR270 cost $99.99. Contact BSR Ltd., Rte. 303, Blauvelt, NY 10913, (914) 358-6060.

Circle 538 on inquiry card.

SOFTWARE

Package of Mysteries

The Applied Mysteries Package consolidates the information in H. C. Pennington's TRS-80 **Disk & Other Mysteries** into easily understood concepts. The package includes disassembled listings of bootstrap loaders with comments, descriptions of encoding methods that render floppy disks difficult to copy, a utility program for viewing a file's device-control block, and procedures for disassembling system files. The Applied Mysteries package (booklet and floppy disk) costs $17.95, plus $2 postage. Contact Applied Softwares, 4316 Vermont Court, Virginia Beach, VA 23456.

Circle 539 on inquiry card.

Print Diagrams of Your Projects

The expanded PMS-II project-management system has the ability to prepare net-change reports that compare the current status of a project to a previous status. In addition to critical-path analysis, data-management, and reporting capabilities, PMS-II can calculate gains and losses that can be displayed in both calendar and net working days format. Accommodating more than 1000 simultaneous activities for each project, PMS-II can calculate a critical-path schedule based upon a three- to seven-day week, while omitting holiday periods.

PMS-II will operate with any microcomputer running under Digital Research's CP/M 2.2 operating system and Compiler Systems' CBASIC 2.07. Two 8-inch disk drives and a 132-column printer are required. PMS-II costs $995. Contact North America Mica Inc., Suite 240, 11772 Sorrento Valley Rd., San Diego, CA 92121, (714) 481-6998.

Circle 540 on inquiry card.

Level II COBOL

Mainframe applications programs written to ANSI 74 COBOL standards can now be transported to microcomputers with minimal conversion thanks to Micro Focus Inc.'s Level II COBOL. The easy-to-install language fully meets the specifications set forth by the American National Standards Institute (ANSI) for Level II COBOL modules, including nucleus, table handling, sequential I/O, relative and indexed I/O, interprogram communication, and sort/merge operations.

Level II COBOL is available for 8086-based computers and any computer with a C language compiler, such as the Z8000, the 68000, and the PDP-11. Contact Micro Focus Inc., 1601 Civic Centre Dr., Santa Clara, CA 95050, (408) 496-0176.

Circle 541 on inquiry card.

What's New?

Get In Synch

Synch is a 2780/3780 IBM binary synchronous software communications package for the Radio Shack TRS-80 Model II. Emulating 2770-, 2780-, and 3780-type bisynchronous work stations at data rates of up to 9600 bits per second, Synch supports transparency, buffer expansion from 128K bytes to 512K bytes, space compression, RVI (processor interrupt), and multipoint circuits. Synch provides low-cost RJE (remote job entry) capabilities and automatic features that allow up to 100 files to be arranged for unattended operations.

Including documentation, Synch costs $500. Contact Westico Inc., 25 Van Zant St., Norwalk, CT 06855, (203) 853-6880.

Circle 542 on inquiry card.

Quic-N-Easi Program Development

The Quic-N-Easi programming system ties together formatted and edited data entry with processing, printing, and file-handling capabilities including index-sequential, sequential, and random-access methods. The system features a screen builder, parameter-driven content editor, an interpreter language, and a print-format handler.

Quic-N-Easi will operated with most CP/M, Z80-based microcomputers with a minimum of 48K bytes and one disk drive. It costs $395, including a self-teaching guide, reference manual, and reference card. Contact Standard Microsystems Inc., 136 Granite Hill Court, Langhorne, PA 19047, (215) 968-0689.

Circle 543 on inquiry card.

Communications Software for Osborne

The Micro-Link communications package is designed exclusively for the Osborne 1's video-display screen. It uses the Osborne's RS-232C port with a standard modem to communicate over telephone lines with other computer users as well as with computerized bulletin boards and information-retrieval services. One such service, The Source, has organized an electronic mailbox for members of the Osborne Users Group. Originate and answer modes as well as full- and half-duplex operation are supported. Operating at 300 bits per second (bps), Micro-link allows files to be transmitted in character, line, or memory-block protocols. Files can be prepared in advance and transmitted automatically, and a complete two-way record of communication can be recorded in memory and on disk.

With documentation and software on disk, Micro-Link costs $89. Contact Osborne Computer Corp., 26500 Corporate Ave., Hayward, CA 94545, (415) 887-8080.

Circle 544 on inquiry card.

Microline Graphics Package

Okidata's all-points-addressable graphics software package lets you create flowing lines and illustrations with any Microline printer. Each dot in the 60- by 66-dot-per-square-inch field is under your control. A software algorithm, supplied on floppy disk, lets you translate data displayed by an Apple computer into parallel data that can be used by the Microline printer. The Apple displays data in a 280 by 192 dot format, and the software sets it up proportionally for printing on a one-to-one basis.

The package consists of two programmable read-only memories (PROMs) and a floppy disk. It's available for the Microline Models 82A and 83A for $100 at local dealers. As a standard feature on the Microline Model 84, the package provides a 72- by 72-dot-per-square-inch format. Contact Okidata Corp., 111 Gaither Dr., Mt. Laurel, NJ 08054.

Circle 545 on inquiry card.

FORTH Source Code

A variety package of FORTH source code containing many previously unpublished FORTH definitions is available on an 8-inch disk from Timin Engineering. The package includes data structures, software-development aids, string manipulators, an expanded 32-bit vocabulary, a screen calculator, a typing practice program, and a menu generation/selection program. Also provided are examples of recursion, <BUILDS. . .DOES> usage, output number formatting, assembler definitions, conversational programs, 100 screens of software, and 100 screens of instructional documentation. The screens can be used with Timin FORTH or any other FIG (FORTH Interest Group) FORTH.

The variety package of FORTH source code costs $75. Contact Timin Engineering Co., Suite E-2, 9575 Genesee Ave., San Diego, CA 92121, (714) 455-9008.

Circle 546 on inquiry card.

Entertainment Products

Arcade Machine, Red Alert, Track Attack, and Midnight Magic are four new entertainment products from Broderbund Software.

Arcade Machine lets you create arcade games for one or two players, featuring monsters, sound effects, automatic scoring, fast loading, and automatic boot to a title page with your name and your game's title in large graphic letters.

Red Alert requires a joystick, which helps you wield radar, ack-ack, and rockets to protect your base against an alien menace. Track Attack is a fast-paced, high-resolution game with color graphics, large-scale animation, and three train-robbery scenar-

ios from which to choose. The Midnight Magic high-resolution pinball game has dual flipper controls, upper and lower playing levels, and a host of other effects.

The products range in price from $29.95 to $49.95. Each requires a 48K-byte Apple II with DOS 3.2 or 3.3. For details, contact Broderbund Software, 1938 Fourth Ave., San Rafael, CA 94901, (415) 456-6424.

Circle 547 on inquiry card.

Depreciation Planner

Designed for the Apple computer, the Depreciation Planner keeps track of depreciable assets for accounting and tax-planning purposes. Incorporating both pre-January 1981 depreciation methods and the new post-January 1981 depreciation methods, the Planner automatically calculates current-month depreciation, year-to-date, and life-to-date amounts. A modeling feature lets you experiment with all forms of depreciation for each asset. Lists of items potentially eligible for investment tax credit in each fiscal year can be printed, as well as a depreciation-projection report listing current and following-year depreciation for individual assets. The Planner can provide a printed list of assets in five formats: tag numbers, location, depreciation type, depreciation method, and asset life.

Contact Dakin5 Corp., 7475 Dakin St., Denver, CO 80221, (303) 426-6090.

Circle 548 on inquiry card.

HP 83/85 File Manager

The Hewlett-Packard File Manager Software Pac gives owners of HP 83/85 computers electronic file-management capabilities. The File Manager lets you create your own forms for entering data into the filing system. Data can be updated, searched, sorted, or even translated to a string data file for use with other software packages, such as Visicalc Plus. Other features include report and graphics capabilities, built-in error trapping and recovery routines, and comprehensive data-integrity checks. Each File Manager file can contain up to 1000 forms; each form can contain up to 1000 alphanumeric characters.

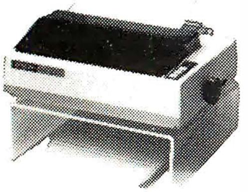
The HP 83/85 File Manager Software Pac is supplied on 5¼-inch floppy disks and is available for $200 at local Hewlett-Packard sales offices. ■

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Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

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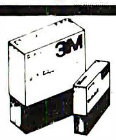
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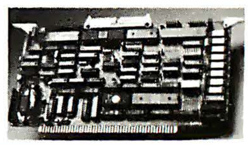
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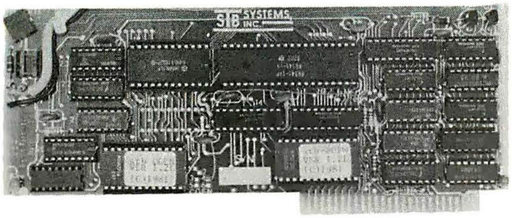
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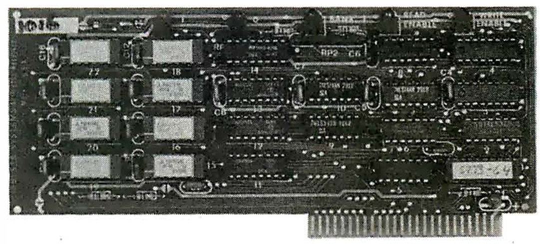
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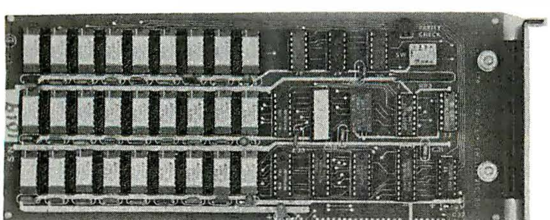
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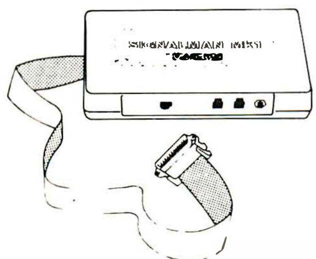
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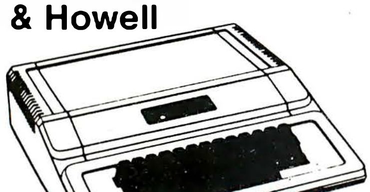
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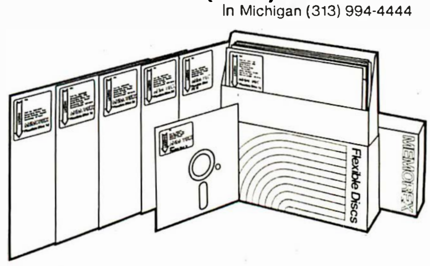
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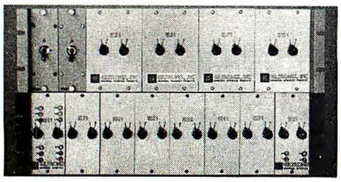
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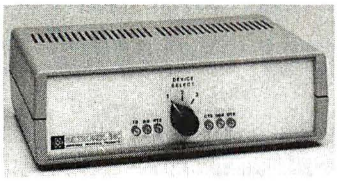
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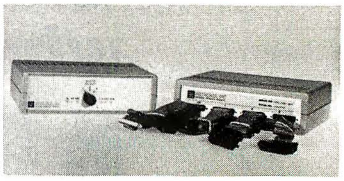
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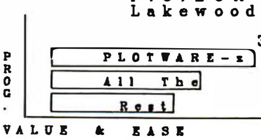
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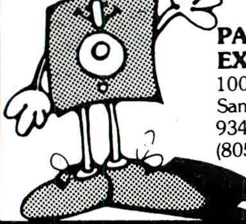


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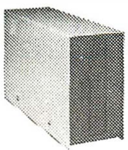
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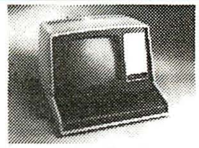
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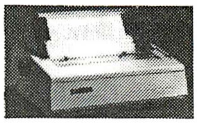
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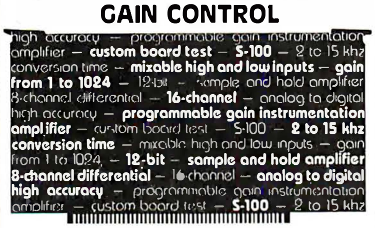
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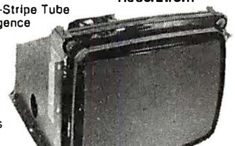
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74365N	.65
74366N	.65
74367N	.65

74LS00TTL	
74LS00N	.25
74LS02N	.25
74LS04N	.25
74LS05N	.25
74LS08N	.35
74LS10N	.25
74LS13N	.45
74LS14N	.99
74LS20N	.25
74LS22N	.25
74LS28N	.35
74LS30N	.25
74LS33N	.55
74LS38N	.35
74LS74N	.45
74LS75N	.50
74LS90N	.60
74LS93N	.65
74LS95N	.85
74LS107N	.40
74LS112N	.45
74LS113N	.45
74LS132N	.75
74LS136N	.49
74LS151N	.75
74LS155N	.79
74LS157N	.75
74LS162N	.95
74LS163N	.95
74LS174N	.95
74LS190N	1.00
74LS221N	1.19
74LS258N	.69
74LS367N	.69

LINEAR	
CA3045	.90
CA3046	1.10
CA3081	1.80
CA3082	1.90
CA3089	3.40
LM301AN/AH	.34
LM305H	.87
LM307N	.35
LM308N	.98
LM309K	1.25
LM311H/N	.64
LM317T	1.65
LM317K	3.75
LM318	1.49
LM320K-5	1.35
LM320K-12	1.35
LM320K-15	1.35
LM320T-5	.85
LM320T-8	.85
LM320T-12	.85
LM320T-15	.85
LM323K-5	4.95
LM324N	.59
LM339N	.99
LM340K-5	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
LM340K-24	1.35
LM340T-5	.75
LM340T-8	.75
LM340T-12	.75
LM340T-15	.75
LM340T-18	.75
LM340T-24	.75
LM350	5.50
LM377	2.29
LM380N	1.00
LM381	1.60
LM382	1.60
LM709H	.59
LM723H/N	.49
LM733N	.85
LM741CH	.35
LM741N	.35
LM747H/N	.75
LM748N	.50
LM1303N	1.75
LM1304	1.10
LM1305	1.27
LM1307	1.10
LM1310	2.75
LM1458	.55
LM1812	8.25
LM1889	2.49
LM2111	1.75
LM2902	2.25
LM3900N	.59
LM3905	1.25
LM3909N	.95
MC1458V	.55
NE550N	1.30
NE555V	.39
NE556A	.65
NE565A	1.00
NE566V	1.50
NE567V	1.00
NE5 708	4.75
78L05	.60
78L08	.60
78M05	.85
75108	1.49
75491CN	.50
75492CN	.55
75494CN	.09

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CD4013	.45
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CD4015	.95
CD4016	.45
CD4017	1.05
CD4018	.94
CD4019	.45
CD4020	.95
CD4021	.95
CD4022	1.10
CD4023	.28
CD4024	.75
CD4025	.23
CD4026	1.65
CD4027	.65
CD4028	.80
CD4029	.95
CD4030	.45
CD4035	.85
CD4040	.95
CD4042	.75
CD4043	.85
CD4044	.85
CD4046	.95
CD4049	.45
CD4050	.55
CD4051	.95
CD4060	1.42
CD4066	.71
CD4068	.39
CD4069	.35
CD4070	.35
CD4071	.30
CD4072	.30
CD4073	.35
CD4075	.30
CD4076	.95
CD4078	.30
CD4081	.30
CD4092	.30
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CD4508	1.95
CD4510	.95
CD4511	.94
CD4515	2.25
CD4516	1.10
CD4518	1.25
CD4520	1.02
CD4527	1.51
CD4528	1.25
CD4553	3.50
CD4566	2.45
CD4583	2.35
CD4585	.95
CD40192	3.00
74C00	.35
74C04	.35
74C10	.35
74C14	.75
74C20	.35
74C30	.35
74C48	1.95
74C74	.85
74C76	.80
74C90	1.25
74C93	1.25
74C154	3.25
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8T24	1.75
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8	.13	22	.30
14	.14	24	.30
16	.16	28	.40
18	.20	36	.58
20	.29	40	.49

WIRE WRAP LEVEL 3

PIN		PIN	
14	.55	24	.93
16	.57	28	1.00
18	.67	40	1.59
2 level 14 pin w/w	.20		

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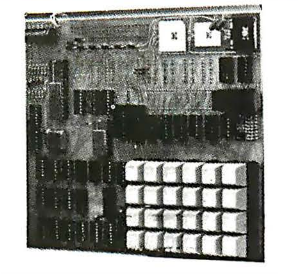
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12V 250 ma	1.95	12V CT 250 ma	3.75
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12.6V CT 2 amps	5.95	12V 1 amp	5.95
12.6V CT 4 amp	8.60	12V 2 amp	7.95
12.6V CT 8 amp	10.80	6, 9, 12 VDC	
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DL747/750	CA/CC	.600	1.49
FND359	CC	.357	.70
FND500/507	CC/CA	.500	.99
FND503/510	CC/CA	.500	.90
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RCA Cosmac 1802 Super Elf Computer $106.95

The Super Elf is a small single board computer that does many **big** things. It's an excellent computer for training and for learning programming with its machine language and yet it's easily **expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for all IC's are included plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** All metal Expansion Cabinet, painted and silk screened, with room for 5S-100 boards and power supply **$57.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

Moews Video Graphics **$3.50,** Games and Music **$3.00,** Chip 8 Interpreter **$5.50,** Starship 4K cassette **$14.95.** Exciting and challenging space game. Complete manual included.

Quest Super Basic V5.0

A new enhanced version of **Super Basic** now available. Quest was the first company worldwide to ship a full size Basic for 1802 Systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range $\pm .17E^{38}$), 32 bit integer $\pm$2 billion; multi dim arrays, string arrays; string manipulation; cassette I/O; save and load, basic, data and machine language programs; and over 75 statements, functions and operations.

New improved faster version including **renumber** and essentially **unlimited variables.**

Also, an exclusive user expandable command library.

Serial and Parallel I/O routines included.

Super Basic on Cassette $55.00.

Free 14 page brochure of complete Super Elf system.

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface.** Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf.** The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake.** They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at **$18.95** for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply below).

ELECTRONIC SYSTEMS KITS

Apple Peripheral Kits

SERIAL I/O INTERFACE 0 to 30,000 baud, D.T.R., Input & output from monitor or basic, or use Apple as intelligent terminal, Bd only (P/N 2) **$14.95,** Kit (P/N 2A) **$51.25,** Assembled (P/N 2C) **$62.95.**

PROTOTYPING BOARD (P/N 7907) **$21.95.**

PARALLEL TRIAC OUTPUT BOARD 8 triacs, each can switch 110V, 6A loads, Bd only (P/N 210) **$19.20,** Kit (P/N 210A) **$119.55.**

OPTO-ISOLATED INPUT BOARD 8 inputs, can be driven from TTL logic, Bd only (P/N 120) **$15.65,** Kit (P/N 120A) **$69.95.**

Interface Kits

SERIAL/PARALLEL INTERFACE Bidirectional, Baud rates from 110 to 19.2K, sw selectable polarity of input and output strobe, 5 to 8 data bits, 1 or 2 stop bits, parity odd or even or none, all characters contain a start bit, +5 & −12V required.Bd only (P/N 101) **$11.95,** Kit (P/N 101A) **$42.89.**

RS-232/TTL INTERFACE Bidirectional, requires ±12V, Kit (P/N 232A) **$9.95.**

RS-232/20mA INTERFACE Bidirectional, 2 passive opto-isolated circuits, Kit (P/N 7901A) **$14.95.**

PROM Eraser

Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled. 25 PROM capacity **$37.50** (with timer **$69.50).** 6 PROM capacity OSHA/UL version **$78.50** (with timer **$108.50).**

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Z80 Microcomputer

16 bit I/O, 2 MHz clock, 2K RAM, ROM Breadboard space. Excellent for control. Bare Board **$28.50.** Full Kit **$99.00.** Monitor **$20.00.** Power Supply Kit **$35.00.** Tiny Basic **$30.00.**

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60 Hz Crystal Time Base Kit $4.40

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Convert TV set into a high quality monitor w/o affecting usage. Comp. kit w/full instruc.

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12v option. ±5v, ±12v are regulated. Basic Kit **$35.95.** Kit with chassis and all hardware **$51.95.** Add $5.00 shipping. Kit of hardware **$16.00.** Woodgrain case **$10.00.** $1.50 shipping.

Type-N-Talk by Votrax

Text to speech synthesizer with unlimited vocabulary, built-in text to speech algorithm, 70 to 100 bits per second speech synthesizer, RS232C interface **$359.00.** Speech IC **$79.95.**

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Expandable to 64K. Hidden refresh w/clocks up to 4 MHz w/no wait states. Addl. 16K RAM **$25.00.**

S-100 4-slot expansion $ 9.95
Super Monitor VI.I Source Listing $15.00

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display ROM monitor;, fully expandable. **$419.00.** 4K version **$449.00.** 4K Assembler **$35.00,** 8K Basic Interpreter **$65.00.**

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AIM 65/KIM/SYM/Super Elf 44 pin expansion board; board with 3 connectors **$22.95.**



Elf II Adapter Kit $24.95

Plugs into Elf II providing Super Elf 44 and 50 pin plus S-100 bus expansion. (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

Super Color S-100 Video Kit $129.95

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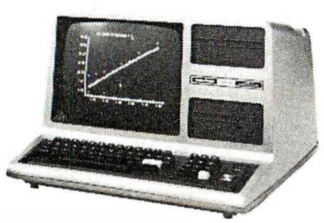
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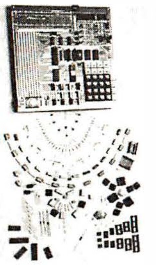
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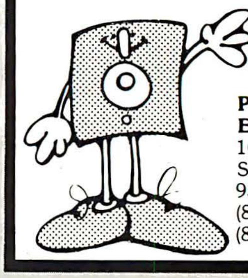
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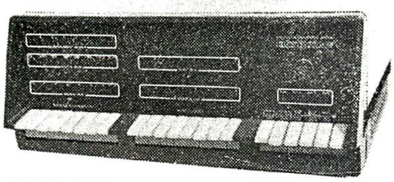
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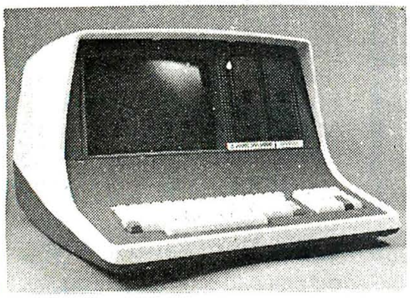
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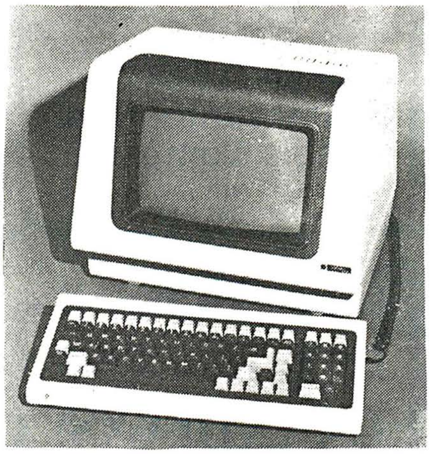
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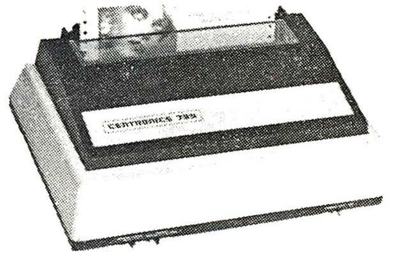
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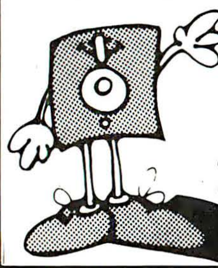
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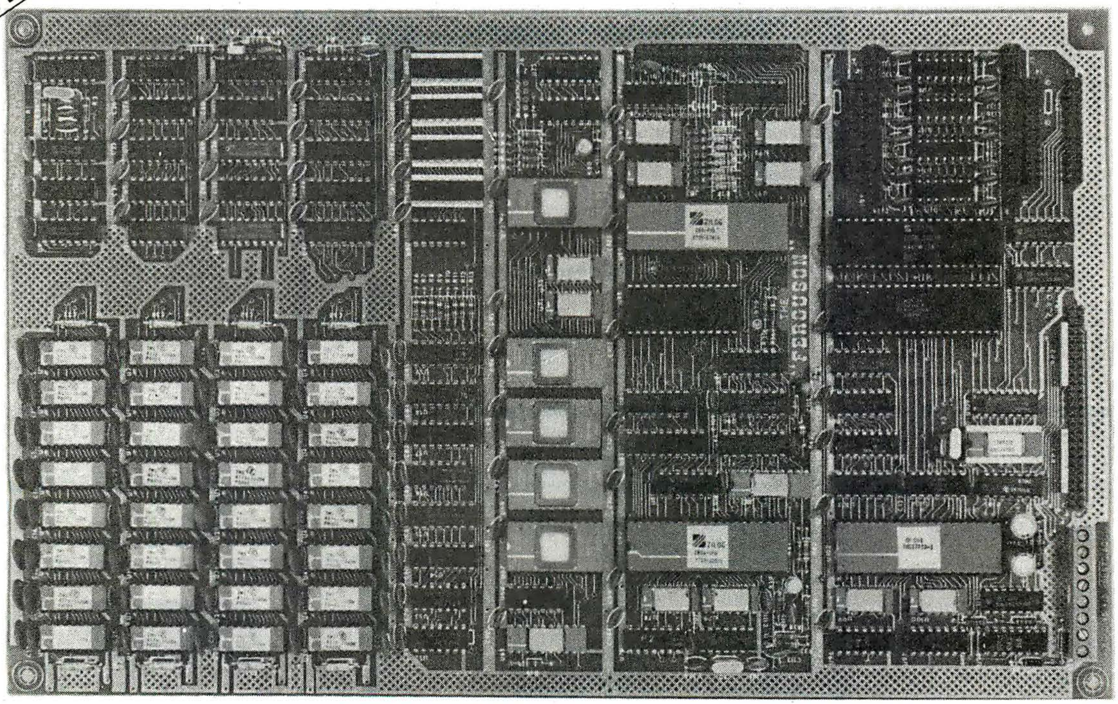
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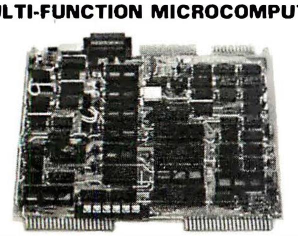
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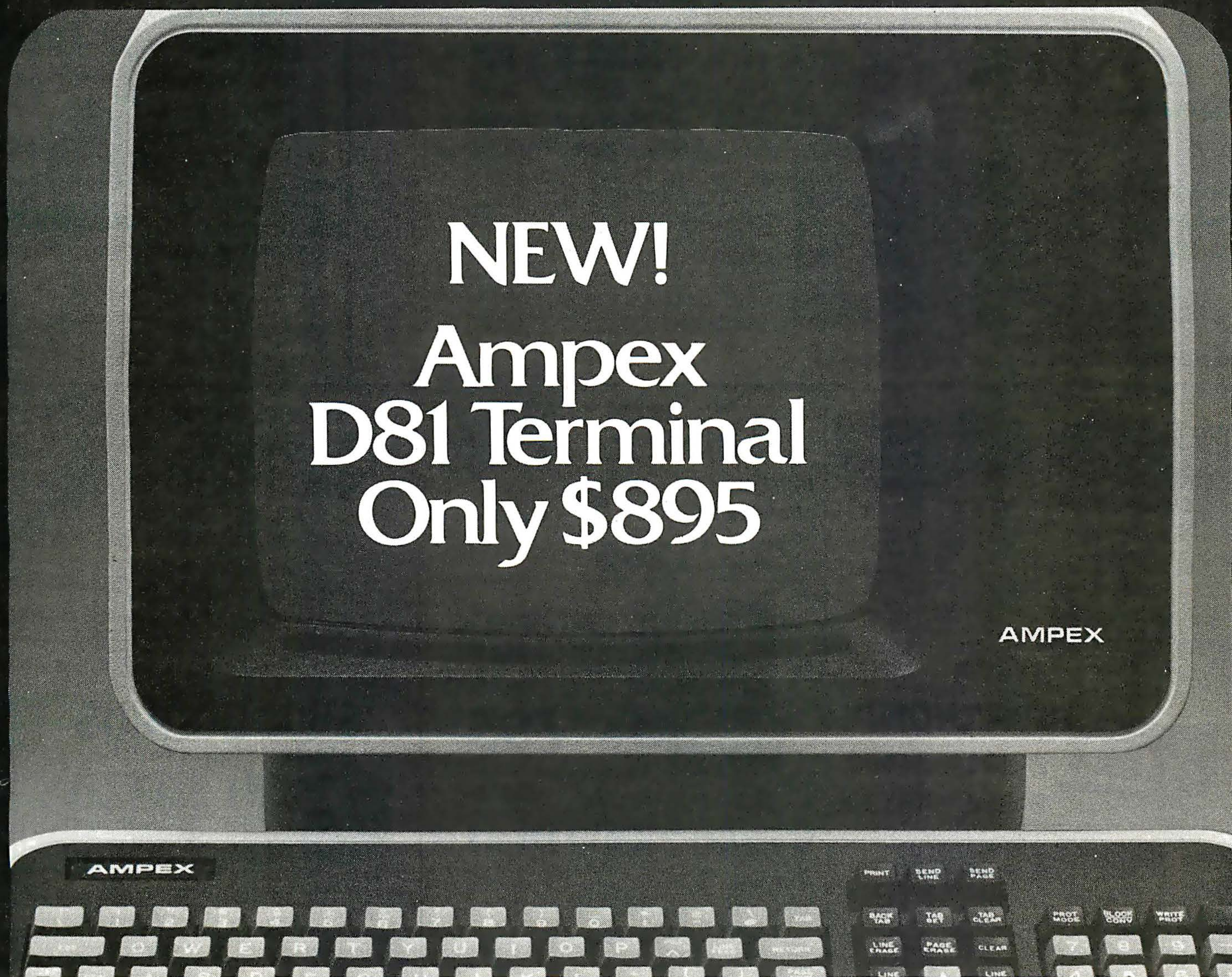
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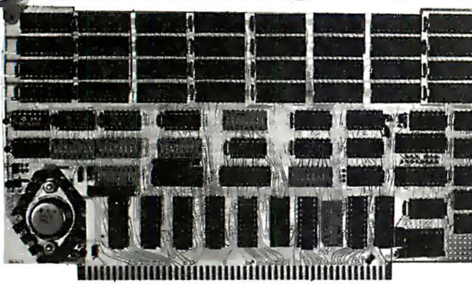
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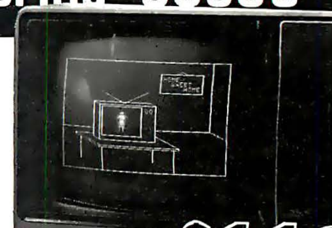
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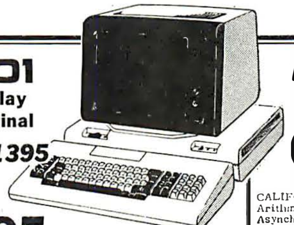
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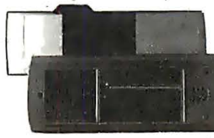
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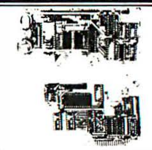
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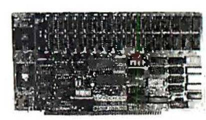
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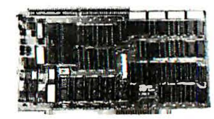


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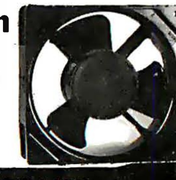
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Morrow Design Disk Jockey I single density	BDF-DJ1	195
Morrow Design Disk Jockey II double density	BDF-DJ2	345
INTERFACE BOARDS		
Calif. Computer 2718 I/O 2 serial/2 par l	BDT-C2718	
Morrow Designs Switchboard 2 serial/4 par l	BDT-MSB	219
Morrow Designs Multiboard 3 serial/3P.+++	BDT-MMB	275
Godbout Interfacer One 2 serial/2 par'l	BDS-GB1	199
Godbout Interfacer Two 1 serial/3 par'l	BDS-GB2	199
SPECIALITY BOARDS		
QT Computer real time clock/calendar	BDS-QCK	135
Artec Elec. Wire wrap prototype board	BDS-AWW	25
Artec Elec. General Purpose proto board	BDS-AGP	25
Godbout Spectrum color board	BDS-GSC	295
D. C. Hayes S-100 Micromodem	BDS-HM1	350
Mullen Products extender board & logic probe kt	BDS-MTBI	49
Mullen Products Opto-contro board kit	BDS-MOC	139

Rotron Muffin Fan

$14.77

$12.00 @ 100
10.50 @ 1000

115 VAC. 7 Watts WR2A1
Factory fresh Muffin fans
NOT pull-outs. EMF-4M



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master charge

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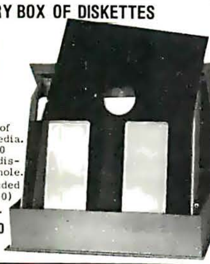
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Ten boxes $22.75 One hundred boxes $21.50



5¼" DISKETTES WITH LIBRARY CASE

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Your Choice
SCOTCH MEMOREX VERBATIM

	Soft Sector	10 Sector	16 Sector	
SCOTCH	744-0	744-10	744-16	$26.50
MEMOREX	3401	3403	3405	26.50
VERBATIM	525-01	525-10	NA	26.50
DYSAN	104/1	107/1	NA	39.50

Single Side Double Density

DYSAN	104/1D	107/1D	NA	45.00

Double Side Double Density

SCOTCH	745-0	745-10	745-16	42.50
DYSAN	104/2D	107/2D	NA	49.50
DYSAN 96	204/2D	NA	NA	59.50

EIGHT INCH DISKETTES

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SCOTCH	740-32	29.50	SCOTCH	743-0	47.50
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Diskette Flip Tubs fifty diskettes 8"		29.95			

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BSR Timer eight channel	$65.00	Appliance Module 500 W.	$13.95
Master control console	34.95	Lamp Module 300 Watts	13.95
Ultrasonic Controller	19.95	NEW full control wall switch	14.50

WINCHESTER SUBSYSTEM

$1250

Includes seven megabyte Winchester hard disk, dual enclosure and power supply.
Floppy backup drive $199.00 additional.



MEMORY

64K DYNAMIC	16K STATIC
$9.95	$13.95
4164 100+	2167 70ns.
16K DYNAMIC	**2716 EPROM**
$2.10	$4.95
4116 100+ $1.85	100+ $4.50 1K+ $4.00



2732 EPROM SALE $7.95

STATIC

		ea.	32+	100+	1K+
21L02	1K	1.19	1.09	1.05	.99
2114	300ns.	2.95	2.75	2.50	1.99
4044-4	450ns.	4.50	4.19	4.00	3.75
4044-2	250ns.	4.95	4.65	4.50	4.25
6116	16k 24 pin	7.95	7.50	6.75	5.45
2167/6167	20 pin	11.95	10.75	9.65	9.25

EPROM

2708	450ns.	3.95	3.50	3.25	3.00
2716	5V.	4.95	4.00	3.75	3.50
2716	tri-volt	8.50	7.95	7.65	7.25
2732	Intel/Hitac.	7.95	7.50	7.00	6.65
2532	Texas Inst	12.95	11.50	10.00	9.50
2764	64K Eprom	29.95	27.00	25.00	23.50



direct connect MODEM

Your Choice **$169**

Direct connect modems eliminate loss of information due to the carbon compression associated with acoustic modems. Choose either of these two great units.

The Universal Data Systems 103LP is switch selectable between answer and originate modes. Fully Bell 103 compatable. Directly connects to the new modular telephone jack. 100% powered from the telephone line. No need to locate modem in proximity to A.C. power recepticle. MOD-103LP 2 pounds.

Novation "D" Cat connects to most of the new "Bell" modular handsets. Ideal for multiple line office telephones. Requires external A.C. power. MOD-DCAT 2 Lb.

SWITCHES



DIP SWITCHES pos.	ea.	100+	1K+
4	.88	.75	.69
7	.99	.83	.79
8	1.05	.91	.87
12	1.19	.99	.91



TOGGLE		ea.	100+
7101	on/on	1.19	.98
7103	on/off/on	1.39	1.19
7107	mnt. on	1.39	1.19
7108	mnt. on	1.39	1.19
7205	dpdt mnt	1.85	1.65

CONNECTORS



GOLD EDGE CONNECTORS

S-100 .125" centers	each	10+
Imsai solder .250" row	$2.95	$2.50
Imsai wire wrap (TI)	3.95	3.50
Sullins Hi-Rel. .250"	4.50	4.00
Sullins Hi-Rel. W/W	5.35	4.90
Sullins / Altair .140"	4.95	4.50
.156" Centers (standard)		
22/44 Kim Eyelet	2.50	2.15
36/72 Digital Group S/T	5.95	5.50
36/72 Digital Group W/W	6.60	6.15
43/86 Motorola 6800 S/T	6.60	6.15
43/86 Moto. 6800 W/W	7.00	6.85

INTEGRATED CIRCUIT SOCKETS

	Low Profile each	Low Profile 100+	Wire Wrap each	Wire Wrap 100+
8 pin	$.10	$.09	$.46	$.41
14 pin	.10	.09	.45	.41
16 pin	.12	.11	.50	.45
18 pin	.15	.13	.68	.61
24 pin	.26	.24	.94	.87
40 pin	.42	.40	1.60	1.47

"D" Type	each	10-24	25+
DE9P male	$1.60	$1.40	$1.30
DE9S female	2.25	2.00	1.90
DE hood	1.50	1.35	1.20
DA15P male	2.35	2.15	2.00
DA15S female	3.25	3.10	2.90
DA hood 2/P	1.60	1.35	1.30
DB25P male	2.50	2.35	2.25
DB25S female	3.35	3.15	3.05
DB hood 2/P	1.35	1.15	1.05
DC37P male	4.20	4.00	3.70
DC37S female	6.00	5.75	5.50
DC hood 2/P	2.25	2.00	1.75
DD50P male	5.50	5.10	4.75
DD50S female	9.40	8.60	8.00
DD50 hood 2/P	2.60	2.40	2.10
CENTRONICS			
57-30360	7.95	6.75	5.75
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17/34 5" disk	4.85	4.15	3.95
20/40 TRS-80	5.65	5.05	4.70
25/50 8" disk	5.90	5.15	4.90



NEW OLIVETTI 801 Eight Inch Disk Drive $295

		ONE	TWO	TEN
★ OLIVETTI 801	single	$319	309	295
★ OLIVETTI 802/851	double	425	419	410
SHUGART 801/R	single	395	385	375
SHUGART 851/R	double	525	495	475
QUME DATA TRACK 8	double	525	495	475

★ The 8" Olivetti drives are aprox. ½" wider than the Shugarts.

Five Inch Disk Drives

OLIVETTI 501/400	single	199	185	175
OLIVETTI 502/451	double	235	225	215

Upon request, all drives are supplied with power connectors and one manual per order.

230 volt 50Hz. 8" add $50.00 per drive.



$995 ***Eight Inch Subsystem***

Two Olivetti 801 disk drives with power supply, 4" exhaust fan complete in dual enclosure with all necessary power cables. Documentation included. 50 Lbs. CAL-2801

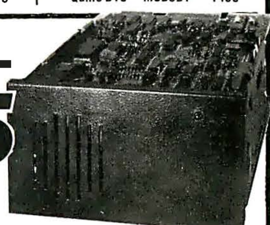
Signal cable add $35.00 WCA-650D

Same as above but with:

Shugart 801R	MSD2801	$1195	Olivetti 802	CAL2802	$1250
Shugart 851R	MSD2851	1450	Qume DT8	MSD8DT	1450

SPECIAL

$895



Volumn Pricing Upon Request

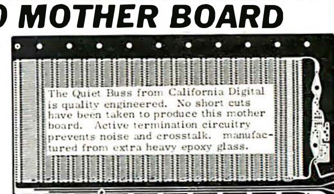
Seagate Compatable 7.5 MEGABYTE Winchester Hard Disk Drive

We have priced this so low that the manufacturer has asked not to use their brand name in our advertising.
Industry standard Seagate plug compatable. Drive fits into the same space as a 5¼" floppy disk drive. CAL-561/2

S-100 MOTHER BOARD

$35

IMSAI
18 Slot
CAL-M18



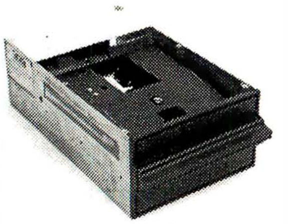
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Foreign orders 10% shipping. Excess will be refunded.
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SPECIAL!!!!!!!! QUME DATATRAK 8

Virtually the industry standard. High quality/reliability. Full featured, double sided, double density.

Tandon TM 848 .... $545

$525 quantity 1, $499 quantity 2 up.

TANDON DOUBLE SIDED, DOUBLE DENSITY MINIS

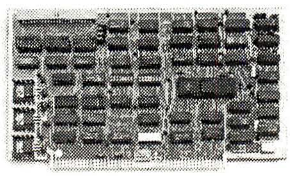
TM100-2 . . . . 48 TPI (500 KBYTES) $325
Compatible with Northstar, Cromemco, TRS-80

TM100-4 . . . . 96 TPI (1000 KBYTES) $425
Compatible with Zenith, Heath, etc.

TANDON 5 ¼" HARD DISKS

TM 602 (5MB) $1195
TM 603 (10MB) $1295

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Tarbell single density kit $195
Tarbell single density A & T $310
Tarbell double density A & T $425
CCS 2422 w/CPM 2.2 .... $350
Godbout Disk 1 .... $450
MDA MXV-21 LSI-11 controller (RX-01, RX-02 compatible) $1050

MISCELLANEOUS

2 Disk drive enclosure ..... $ 95
(fits Siemens, Shugart, Qume)
CP-206 power supply $110
(powers two floppies)

Mini-Enclosure with power supply
1 drive ...... $ 85
2 drives $120

Cable Kits 2 drives ...... $ 35
3 drives ...... $ 40
4 drives ...... $ 45
Diskettes ss $39/10 — ds $59/10

CPU

CCS 2810 .... $ 275
Godbout Z-80A .... $ 275
Godbout 8085A .... $ 295

MEMORY

CCS 2065 64K dynamic .... $ 595
CCS 2116 32K static .... $ 625
Godbout RAM 17 64K .... $ 675

I/O

CCS 2710 4 SIO .... $ 325
Godbout Interfacer 1 .... $ 225
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DAISY WHEEL PRINTER . . $2395
45 CPS, RO. Available in KSR version.
Call for further particulars.
Ribbons: $125/case
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NEW !!!!
ABM 85 Video Terminal . . $ 895
— Detachable keyboard
— Televideo 920, ADM 3A compatible
— High resolution green phosphor (23 MHZ)
— Extra multi-bus or S-100 slot for stand-alone capability

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*Micro B +
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*Level I $249
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*C Compiler $175/20
*Disk Doctor .... $ 84/20
*Term I $129/25
Term II $169/25
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Others less 10%

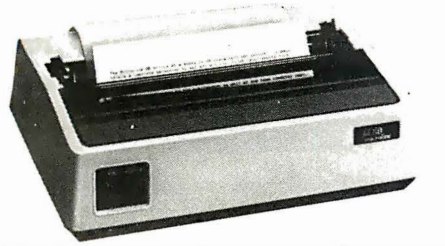
WHITESMITHS
C Compiler $600/30
Pascal (incl C) $850/45
Call for catalog and other listings

* Available for Apple with Softcard

Circle 180 on inquiry card.

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BETTER THAN EPSON ! - Okidata



Microline 82A *80/132 column,* ***120 CPS,*** *9 x 9 dot matrix, friction feed, pin feed, adjustable tractor feed (optional), handles 4 part forms up to 9.5" wide, rear & bottom feed, paper tear bar, 100% duty cycle/200,000,000 character print head, bi-directional/logic seeking,* ***both serial & parallel interfaces included,*** *front panel switch & program control of 10 different form lengths, uses inexpensive spool type ribbons, double width & condensed characters, true lower case descenders & graphics*

PRM-43082 *Friction & pin feed* **$499.95**

Microline 83A *132/232 column, 120 CPS, handles forms up to 15" wide, removable tractor, plus all the features of the 82A.*

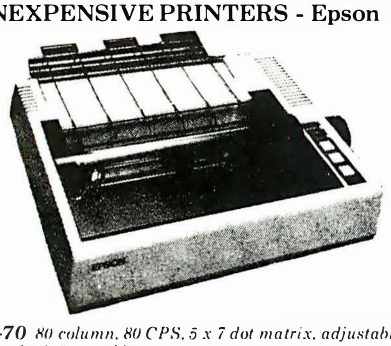
PRM-43083 *with FREE tractor* **$744.95**

Microline 84 *132/232 column, 200 CPS, full dot graphics built in, handles forms up to 15" wide, plus all the features of the 83A.*

PRM-43083 *with FREE tractor* ... **$1149.95**

PRA-27081	*Apple card*	**$39.95**
PRA-27082	*Apple cable*	**$19.95**
PRA-27087	*TRS-80 cable*	**$24.95**
PRA-43081	*2K hi spd serial card*	**$169.95**
PRA-43082	*Graphics ROMs 82A*	**$79.95**
PRA-43083	*Graphics ROMs 83A*	**$79.95**
PRA-43088	*Tractor option 82A*	**$39.95**
PRA-43080	*Extra ribbons pkg. of 2*	**$9.95**

INEXPENSIVE PRINTERS - Epson



MX-70 *80 column, 80 CPS, 5 x 7 dot matrix, adjustable tractor feed, & graphics*

PRM-27070 *List $459* **$389.95**

MX-80 *80 column, 80 CPS, bi-directional/logic seeking printing, 9 x 9 dot matrix, adjustable pin feed, & 64 graphics characters*

PRM-27080 *List $645* **$429.95**

MX-80FT *same as MX-80 with friction feed added.*

PRM-27082 *List $745* **$529.95**

MX-100 *132 column, correspondence quality, graphics, up to 15" paper, friction feed & adjustable pin feed, 9 x 9 dot matrix, 80 CPS.*

PRM-27100 *List $945* **$724.95**

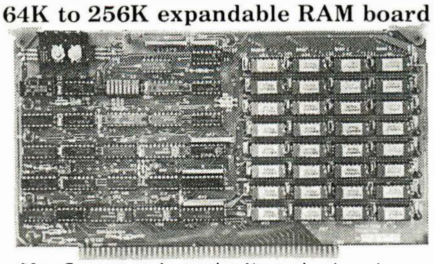
PRA-27084	*Serial interface*	**$54.95**
PRA-27088	*Serial intf & 2K buffer*	**$144.95**
PRA-27081	*Apple card*	**$39.95**
PRA-27082	*Apple cable*	**$19.95**
PRA-27086	*IEEE 488 card*	**$52.95**
PRA-27087	*TRS-80 cable*	**$24.95**
PRA-27085	*Graftrax II*	**$75.00**
PRA-27090	*Extra print head*	**$44.95**
PRA-27083	*MX-80 ribbon cart.*	**$13.95**
PRA-27101	*MX-100 ribbon only*	**$9.95**

16K RAM Card for Apple II was $175, Now Only $74.95

Expand your Apple's memory from 48K to 64K with this assembled & tested RAM Card that just plugs right into your Apple. Take advantage of this half price sale !!!

MEX-16700A *16K RAM Card* **$74.95**

SD Systems
ExpandoRAM III
64K to 256K expandable RAM board

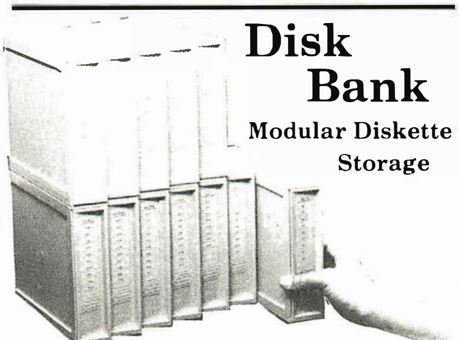


SD Systems has duplicated the famous reliability of their ExpandoRAM I and II boards in the new ExpandoRAM III, a board capable of containing 256K of high speed RAM. Utilizing the new 64K x 1 dynamic RAM chips, you can configure a memory of 64K, 128K, 192K, or 256K, all on one S-100 board. Memory address decoding is done by a programmed bipolar ROM so that the memory map may be dip-switch configured to work with either COSMOS/MPM-type systems or with OASIS-type systems.

Extensive application notes concerning how to operate the ExpandoRAM III with Cromemco, Intersystems, and other popular 4 MHz Z-80 systems are contained in the manual.

MEM-65064A	*64K A & T*	**$424.95**
MEM-65128A	*128K A & T*	**$494.95**
MEM-65192A	*192K A & T*	**$559.95**
MEM-65256A	*256K A & T*	**$595.00**

Disk Bank
Modular Diskette Storage



The Disk Bank system is a revolutionary diskette storage concept designed to handle all your diskette storage needs no matter how small or large.

The Disk Bank system can grow as your storage needs grow. Its modular interlocking design allows you to add to your system horizontally or verticallly. And Disk Bank's design allows easy accss to your diskettes. Just open the drawer and slide it out. The diskette retaining gate falls forward automatically for easy access to any of the 10 diskettes, without fear of bending or crimping. Shipping weight 1 lb.

MMA-405 *5¼" Disk Bank* **$4.95**

MMA-408 *8" Disk Bank* **$5.95**

Modems on Sale !!!!



SIGNALMAN - Anchor

Direct-connect automatic answer/originate selection, 300 Baud full duplex, Bell 103, includes RS-232 cable

IOM-5600A *Signalman* **$98.50**

SMARTMODEM - Hayes

Sophisticated direct-connect auto-answer/auto-dial modem, touch-tone or pulse dialing, RS-232C interface, programmable

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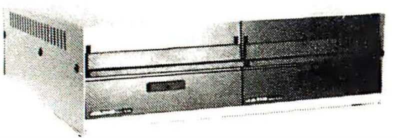
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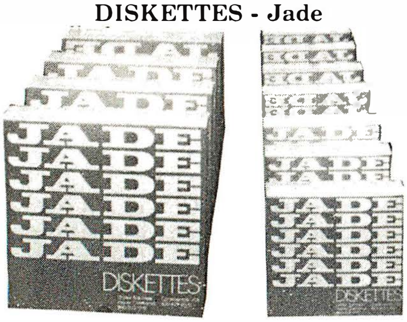
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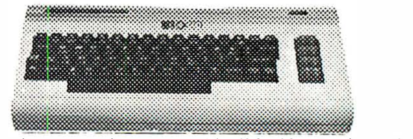
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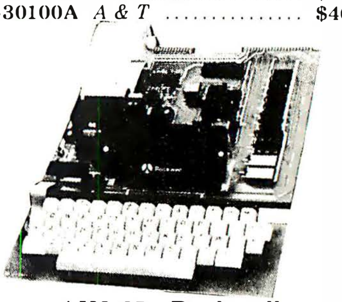


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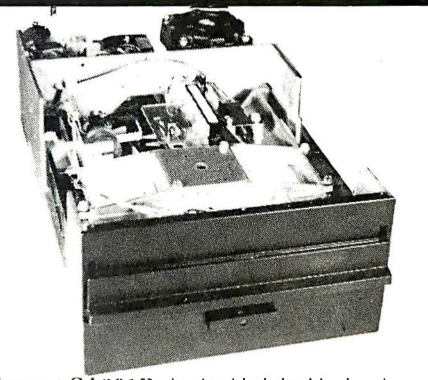
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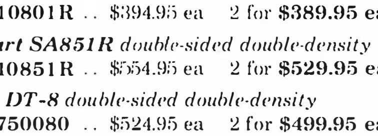
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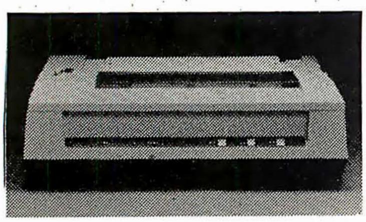
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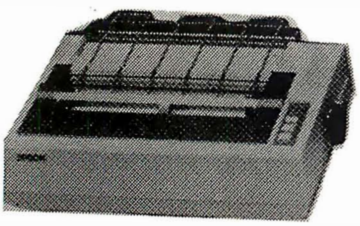
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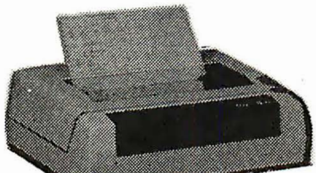
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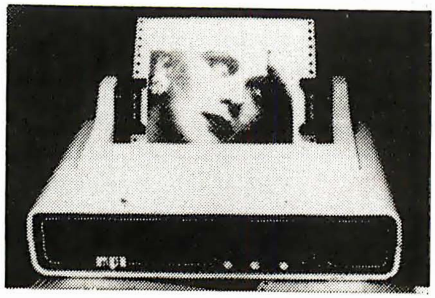
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UP TO 200 CPS!

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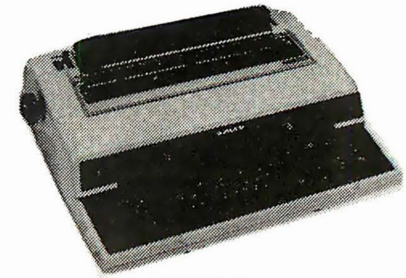
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84SP $1250

MODEMS

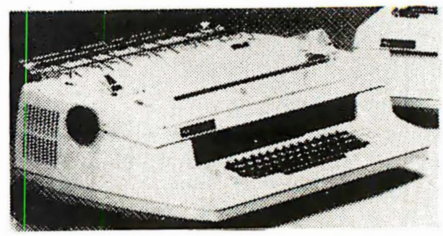
UDS 103 LP, *direct* $169
103 JLP *Auto Answer* $209
202 LP *1200 BAUD* $259
NOVATION CAT, *acoustic* $145
D-CAT, *direct* $155
Auto Cat $219
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HAYES S100 Micromodem $349
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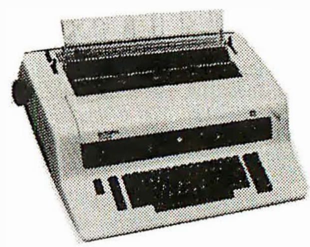
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Pro Easy Writer	$196.99
Easy Writer 40 col.	$78.99
Ward Star (Req. Softcard)	$241.99
Super Sort (Req. Softcard)	$129.99
Mail Meger (Req. Softcard)	$80.99
Data Star (Req. Softcard)	$192.99
Spell Star (Req. Softcard)	$129.99
Calle Star (Req. Softcard)	$129.99
Super Tex II	$117.99
The Address Book	$38.99
Form Letter Module	78.99
Visifiles	$229.99
Desktop Plan III	$275.99
Desktop Plan II	$229.99
Visiplot	$185.99
Visitrend/Visiplot	$275.99
Visidex	$229.99
Visiterm	$89.99
Visicalc 3.3	$229.99
Infotory	$199.99
Superspell (Req. Softcard)	$435.99
Word Processor (Req. Softcard)	$255.99

PERSONAL/HOME

Item	Price
Typing Tutor	$19.99
Elementry Math	$31.99
Personal Filing System	$74.99
Personal Report System	$74.99
Algebra I	$31.99
Compu-Math: Arithmetic Skill	$39.99
Compu-Math: Fractions	$31.99
Compu-Math: Decimals	$31.99
Compu-Spells: (Reg. Data Disk)	$23.99

MISC

Item	Price
Applesoft Compiler	$165.99
Basic Compiler	$315.99
Apple-Doc	$41.99
D.B. Master	$189.99
D.B. Utility Pack	$81.99

GAMES

Item	Price
Raster Blaster	$24.99
Air Traffic Controller	$9.99
Temple of Apshai	$31.95
Datestones of Ryn	$15.99
Morloc's Tower	$15.99
Rescue at Rigel	$23.99
Hell Fire Warrior	$31.99
Star Warrior	$31.99
Crash, Crumble and Chomp	$23.99
Upper Reaches of Apshai	$15.99
The Keys to Acheron	$15.99
Snack Attack	$23.99
The Prisoner	$23.99
Zonk I	$31.99
Zonk II	$31.99
Robot Wars	$31.99
Three Mile Island	$31.99
L.B.M.	$19.99
Castle Wolfenstein	$23.99
Wizard and Princes	$25.99
Missile Defense	$23.99
Cranston Manor	$27.99
Warp Destroyer	$23.99
Cyber Strike	$31.99
Phantoms Five	$23.99
Space Eggs	$23.99



APPLE ACCESSORIES

MICROSOFT

Item	Price
Z80 Softcard	$299.99
16K RAMcard	$158.99

CCS

Item	Price
Parallel Card	$119.99
ASYNC Serial Card	$148.99
Clock Calender Card	$99.99
IEEE Card	$249.99
A-D Card	$99.99

MOUNTAIN COMPUTERS

Item	Price
Romolus	$129.99
Keyboard Fitter Rom	$49.99
CPS Multifunction Card	$189.99
Super talker	$229.99

PAYMAR

Item	Price
L/C Adapter-New	$35.99
L/C Adapter-Old	$45.99
Videx-Video Term	$299.99

ADVANCE BUSINESS TECH

Item	Price
13 Key pad for Apple (New KBD)	$110.99
13 Key pad for Apple (Old KBD)	$110.99
BAR Code Reader	$189.99
Dana-Cooling Fan	$39.99
Lazer-Lower Case Adapter	$55.99

T.G. PROD.

Item	Price
Game Paddles	$31.99
Joy Stick	$46.99
Select A Port	$46.99
Wizard-80 (80 col.)	$278.99

RS232 CABLES

Item	Price
4 wire male-male 10 ft.	$19.99
9 wire male-male 10 ft.	$21.99
4 wire male-female 10 ft.	$19.99
9 wire male-female 10 ft.	$21.99
RS232 Switch Box (Use 2 terminals or printers from one output port)	$109.99

FAN FOLD PAPER

(Prices F.O.B. S.P.)

Item	Price
9½x11-20# Bond White (2700 ct.)	$30.10
14⅞x11-20# Bond White (2400 ct.)	$37.10
14⅞x11-20# Bond ½" Green Bar (2400 ct.)	$37.10

RIBBONS

Item	Price
NEC	$77/Doz.
Qume	$45/Doz.
Diablo	$66/Doz.
Anadex	$135/6 ea.
Tritel	$95/Doz.
TI/DEC/TTY	$45/Doz.
Epson	$13.95/ea.
MPI/Axiom/Base 2	$13.95/ea.

MAGNETIC MEDIA

Premium Quality At Bargain Prices
100% Certified with hub rings, box of 10

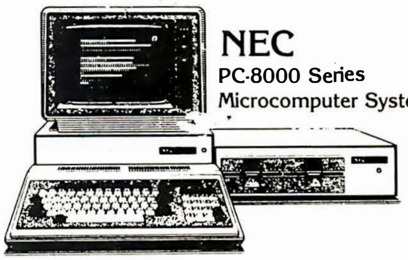
Economy Diskettes

Item	Price
5¼" SSSD Soft, 10 or 16 sector	$25.00
SSSD Soft, 10 or 16 sector	$28.50
DSDD Soft, 10 or 16 sector	$36.00

Quality Diskettes

Item	Price
5¼" SSD, Soft 10 or 16 sector	$27.00
SSDD, Soft 10 or 16 sector	$32.00
DSDD, Soft 10 or 16 sector	$38.50
8" SSSD, Soft or 32 hard sector	$28.50
DSDD, Soft or 32 hard sector	$45.50

CALL for prices on name brand diskettses:
VERBATIM DYSAN 3M SCOTCH
MEMOREX WABASH MAXELL



NEC
PC-8000 Series
Microcomputer System

- z-80A CPU 4 MHz
- 5 user programmable function keys
- 82 Keys with numeric keypad
- 160 x 100 resolution
- 80 character screen

Item	Price
PCX-8001A Microcomputer w/32K RAM	$899
PC-8012A I/O Unit w/32K RAM Expansion slots	$599
PC-8031A Dual Mini-Disk Drive Unit	$899
PC-8032A Add-On Dual Mini Disk Drive Unit	$799

ATARI SOFTWARE

Item	Price
Adventure # 1,2,3, (D)	$31.99
Adventure #4,5,6, (D)	$31.99
Adventure #7,8,9 (D)	$31.99
Adventure #10,11,12 (D)	$31.99
Adventure 1-12 (D)	$79.99
Atari Mailing List (D)	$19.99
Text Wizard (D)	$79.99
Compu-Math/Fractions (D)	$31.99
Compu-Math/Decimals (D)	$31.99
Compu-Math/Fractions (D)	$23.99
Compu-Math/Decimals (C)	$23.99
Letter Perfect (D)	$119.99
Mail Merge/Utility (D)	23.99

TO PLACE YOUR ORDER CALL:

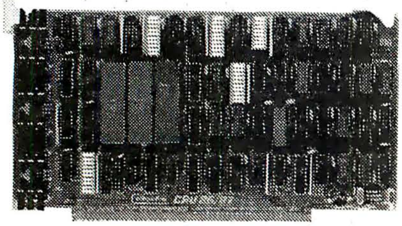
TELEPHONE (714)744-7314 CODE: BApr82 or write to: *TELEX* 697120

PALOMAR
Computer Products

910-105 W. San Marcos Blvd., San Marcos, CA 92069

TERMS OF SALE: Cash, check, money order, bank wire transfer, credit card or purchase orders from qualified firms and institutions. Please include telephone number with order and expiraton date on credit card orders. California residents add 6% sales tax. Advertised prices are for prepaid orders F.O.B. shipping point. Add 3% for shipping in U.S. Pricing and availability subject to change without notice.

S-100 CPU



CO - PROCESSOR 8086 - 8087 COMPUPRO
Math co-processor

PART NO.	DESCRIPTION	LIST PRICE	OUR PRICE
BEGBT186A	A&T 8086 Only	$695.00	$625.00
BEGBT186C	CSC 8086 Only	$850.00	$765.00
BEGBT8087	8087 Chip		CALL

CPU-Z - GODBOUT
2/4 MHZ Z80 CPU 24 Bit Addressing

BEGBT 160A	A & T	$295.00	$260.00
BEGBT 160C	CSC 3-6 MHZ	$395.00	$375.00

DUAL PROCESSOR 8085-8088 - COMPUPRO
6 or 8 MZ Provides true 16 Bit Power with a standard 8 bit S-100 bus.

BEGBT 1612A	A & T 6 MHZ	$425.00	$399.00
BEGBT 1612C	CSC 6/8 MHZ	$525.00	$496.00

MPM (816)™ — COMPUPRO
Runs CPM 80™, CPM 86™, And MPM86™ AT THE SAME TIME! 8 AND/OR 16 BIT TOGETHER! WOW!

BEGBTMPM816	Software	$995.00

See Compupro AD in May BYTE for details

SOLID STATE DISK DRIVE, 3500% FASTER!
Not Really, But the Next Best Thing For Compupro 8085/88 Users. Call for Details on M-Drive.

BEGBT MD 128K	$1,550.00
BEGBT MD 256K	$3,000.00

2810 Z80 CPU-CA. COMP. SYST.
2/4 MHZ Z80A CPU with RS232C Serial I/O Port complete with Monitor PROM for 2422 Disk Controller

BECCS 2810A	A & T	$350.00	$260.00

CB2 Z80 CPU - S.S.M.
2/4 MHZ will accept 2716, or 2732, or RAM

BESSMCB2K	Kit		$260.00
BESSMCB2A	A & T	$344.00	$310.00
BESSMZ6DM	SSMZ80 Monitor		$69.00

S-100 I/O BOARDS

SYSTEM SUPPORT 1 - GODBOUT
Serial port (software prog baud), 4K EPROM OR RAM provision, 15 levels of interrupt, real time clock, optional math processor

PART NO.	DESCRIPTION	LIST PRICE	OUR PRICE
BEGBT162A	Assembled & Tested	$399.00	$360.00
BEGBT162C	CSC	$495.00	$460.00
BEGBT8231	Math Chip		$195.00
BEGBT8232	Math Chip		$195.00
BEGBT162AM1	A&T with 8231 Math Chip		$555.00
BEGBT162CM1	CSC with 8231 Math Chip		$655.00
BEGBT162AM2	A&T with 8232 Math Chip		$555.00
BEGBT162CM2	CSC with 8232 Math Chip		$655.00

MPX CHANNEL BOARD - COMPUPRO
I/O Multiplexer, using 8085A-2 CPU on board

With 4K RAM

BEGBT166A4	A & T	$495.00	$445.00
BEGBT166C4	CSC	$595.00	$535.00

With 16K RAM

BEGBT166A16	A & T	$649.00	$585.00
BEGBT166C16	CSC	$749.00	$675.00

INTERFACER I - COMPUPRO
Two Serial I/O

BEGBT133A	A & T	$249.00	$219.00
BEGBT133C	CSC	$324.00	$298.00

INTERFACER II - COMPUPRO
Three parallel, one serial I/O board

BEGBT150A	A & T	$249.00	$219.00
BEGBT150C	CSC	$324.00	$289.00

INTERFACER III - COMPUPRO
Eight channel multi-use serial I/O board

BEGBT1746A	A & T	$699.00	$629.00
BEGBT1746C	CSC 200 hr. 8 Port	$849.00	$750.00
BEGBT1745A	A & T	$599.00	$559.00
BEGBT1745C	CSC 200 hr. 5 Port	$699.00	$629.00

MULTI I/O - MORROW DESIGNS
Three Serial, Two parallel

BEMOSMB3200	A & T	$359.00	$329.00

SWITCHBOARD - MORROW DESIGNS
Two serial I/O, four parallel I/O, one status port, one strobe port

BEMOSSB2411		$299.00	$269.00

I/O4 - SSM
Two serial I/O, two parallel I/O

BESSMI04K	Kit		$210.00
BESSMI04A	A & T	$290.00	$260.00

I/O 5 - SSM
2 Serial, 3 Parallel including 1 Centronics

BESSMI051	A & T	$329.00	$309.00

I/O 8 - SSM
8 Port Serial I/O with Timer

BESSMI08A	A & T	$550.00	$495.00

2710 4 PORT SERIAL - CCS
4 Full handshaking RS232 ports and optional 2K ROM

BECCS271001	A & T	$360.00	$310.00

2719 2 SERIAL & 2 PARALLEL - CCS
2 RS232C ports, 2 8 bit parallel ports, & optional 2K ROM

BECCS271901	A & T	$360.00	$325.00

2720 4 PORT PARALLEL - CCS
4 8 bit parallel ports and optional 2K ROM

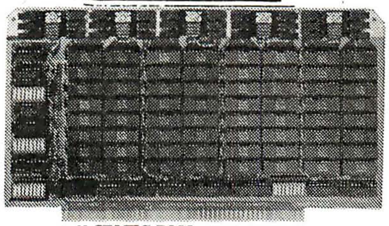
BECCS272001	A & T	$250.00	$225.00

S-100 10 MHZ STATIC RAM

NEW LOW PRICES!

RAM 20 - 32K

CompuPro™



32K STATIC RAM - COMPUPRO
RAM 20 10 MHZ, 4K byte block disable, bank select or 24 bit addressing available 8, 16, 24 or 32K

PART NO.	DESCRIPTION	LIST PRICE	OUR PRICE
BEGBT164AA8	8K A&T	$210.00	$190.00
BEGBT164AC8	8K CSC	$280.00	$260.00
BEGBT164AA16	16K A&T	$285.00	$260.00
BEGBT164AC16	16K CSC	$355.00	$325.00
BEGBT164AA24	24K A&T	$355.00	$325.00
BEGBT164AC24	24K CSC	$425.00	$365.00
BEGBT164AA32	32K A&T	$425.00	$385.00
BEGBT164AC32	32K CSC	$495.00	$450.00

CMOS STATIC RAM
For a complete analysis of the advantages of CMOS memory, see the "Product Description" on page 416 of the January Issue of BYTE.

64K CMOS STATIC RAM - COMPUPRO
RAM 17, 10 MHZ, 2 Watt, DMA Compatable 24 Bit Addressing

BEGBT175A64	64K A&T	$599.00	$550.00
BEGBT175C64	64K CSC 200hr.	$699.00	$650.00

NEW! 32K x 16 BIT CMOS STATIC RAM - COMPUPRO
8 and/or 16 Bit
(816) RAM 16 10 MHZ, 32K x 16 or 64K x 8 IEEE/696 16 BIT 2 Watt, 24 Bit Addressing

BEGBT160A	64K A&T	$650.00	$599.00
BEGBT160C	64K CSC	$750.00	$699.00

NEW! 128K NMOS STATIC RAM - COMPUPRO
RAM 21 15MHz, 128K X 8 OR 64K x 16 IEEE/696 8 or 16 Bit 1.2 Amps 24 Bit Addressing

BEGBT190A	128K A&T	$1695.00	$1610.00
BEGBT190C	128K CSC	$1895.00	$1795.00

S-100 PROM

PBI PROM PROGRAMMER - SSM
Programs 2708 or 2716's, operates as a 4K/8K EPROM BOARD AS WELL.

BESSMPB1K	Kit		$179.00
BESSMPB1A	A & T	$265.00	$220.00

ECONOROM 2708 - COMPUPRO
16K x 8 EPROM Board using 2708, Power on jump to any 256 byte

BEGBT125A	A & T	$135.00	$120.00
BEGBT125C	CSC	$195.00	$175.00

MB8A - SSM
1K/16K 2708 EPROM board, disable in 1K increments

BESSMMB8AK	Kit		$114.00
BESSMMB8AA	A & T	$179.00	$159.00

S-100 VIDEO BOARDS

SPECTRUM - COMPUPRO
Color Graphics board with Parallel I/O

BEGBT144A	A & T	$399.00	$349.00
BEGBT144C	CSC	$449.00	$399.00
BEGBT20	Sublogic Universal Graphics Interpreter Software		$35.00

VB - 3 S.S.M.
80 x 25 or 50 character video display Memory Mapped, Parallel Keyboard port

BESSMVB3K24	80 x 24 Kit		$425.00
BESSMVB3A24	80 x 24 A&T	$499.00	$440.00
BESSMVB3UP	80 x 50 Line Upgrade		$ 39.00

VB2-S.S.M.
I/O Mapped Video Board, with Parallel Keyboard port 64 x 16

BESSMVB2K	Kit		$199.00
BESSMVB2A	A & T	$269.00	$229.00

VBBB - S.S.M
Memory Mapped Video Board 64 x 16 character display or 64 x 16 graphics display

BESSMVB1K	Kit		$179.00
BESSMVB1A	A & T	$242.00	$220.00

S-100 CLOCK CALENDAR

BEQTCCCSA	Assembled & Tested	$150.00

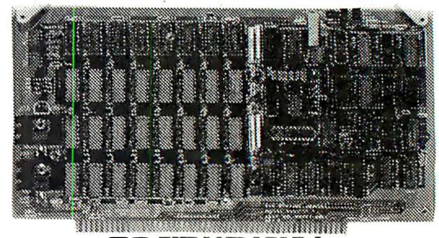
As seen in March Kilobaud Magazine

S-100 MOTHERBOARDS - COMPUPRO

Active termination, 6-12-20 slot

BEGBT153A	A&T 6 slot, 2 lbs	$140.00	$126.00
BEGBT153C	CSC 6 slot, 2 lbs.	$190.00	$175.00
BEGBT154A	A&T 12 slot, 3 lbs.	$175.00	$155.00
BEGBT154C	CSC 12 slot, 3 lbs.	$240.00	$220.00
BEGBT155A	A&T 20 slot, 4 lbs.	$265.00	$235.00
BEGTB155C	CSC 20 slot, 4 lbs.	$340.00	$310.00

S-100 DYNAMIC RAM



THE EXPANDABLE 1
PRIORITY 1 ELECTRONICS

THE EXPANDABLE 1™ 64K Dynamic Ram board provides your S-100 system with 64K of reliable, high-speed dynamic RAM. Compatible with most of the major S-100 systems on the market, including those with front panels, it supports DMA operations and requires no Wait states with current microprocessors. • User expandable from 16 to 64K • Supports DMA • Designed to IEEE proposed S-100 bus standards • 2 or 4 MHz operation • Operates with either an 8080 or Z-80 based S-100 system, providing processor-transparent refreshes with both • Supports IMSAI-type front panels • Jumper-selectable Phantom input • Uses Popular 4116 RAMS • All ICs in sockets • Any 16K block can be made bank-independent • Fully buffered address and data lines • Fail-safe refresh circuitry for extended Wait states • Board configuration with reliable, easy-to-configure Berg jumpers

BEPRIEXP116	16K Assembled & Tested	$299.00
BEPRIEXP132	32K Assembled & Tested	$339.00
BEPRIEXP148	48K Assembled & Tested	$379.00
BEPRIEXP164	64K Assembled & Tested	$409.00

S-100 DISK CONTROLLERS

2422A - CA. COMP. SYST.
I/O Mapped, controls 8", single or double density A&T with CPM 2.2 8" S.D.

	LIST PRICE	OUR PRICE
BECCS2422A	$475.00	$375.00

DISK JOCKEY 2D - MORROW
Memory Mapped, controls 8", single or double density, serial I/O

BEMOIDJ2206	A&T with CP/M 2.2	$399.00	$375.00

S-100 DISK SUBSYSTEMS

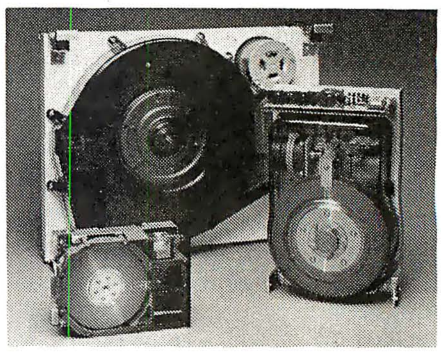
DJ2B DISCUS SINGLE SIDED MORROW
8" DBL Density drives with cabinet, power supply controller, with CP/M 2.2 and Microsoft Basic

BEMOSF1216	Single Drive System	$1095.00	$950.00
BEMOSF1226	Dual Drive System	$1875.00	$1596.00

DJ2B DISCUS DOUBLE SIDED - MORROW
8" DBL Density/sided drives with cabinet Power supply controller, with CP/M 2.2 and Microsoft Basic

BEMOSF2218	Single Drive System	$1395.00	$1250.00
BEMOSF2226	Dual Drive System	$2495.00	$2050.00

S-100 HARD DISK - MORROW



5.25" 5MB, 8" 10 & 20MB, 14" 26MB formatted hard disk complete with cabinet, P.S., Controller, CP/M 2.2 and Microsoft MBASIC 80

		LIST PRICE	SALE PRICE
BEMOSDMAM5	5 MB	$2495.00	$1995.00
BEMOSM10S	10 MB	$3695.00	$2950.00
BEMOSM20S	20 MB	$4795.00	$3625.00
BEMOSM26S	26 MB	$4495.00	$3495.00

WOW!



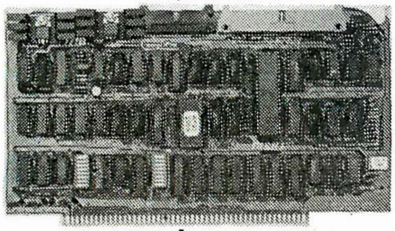
OUTPERFORMS MONITORS OF TWICE THE PRICE!
USI has the competition buckling at their knees! You can have a professional performing Video Monitor for a fraction of the cost! The USI EV2131N is a 12" Green, high resolution data display compatable with 80 x 24 computer formats

BEUSIEV2131N	24 lbs.	$149.00

Circle 342 on inquiry card.

PRIORITY ONE ELECTRONICS

COMPUPRO DMA DISK 1 WITH FREE CP/M 2.2 SALE $450.00



SAVE $220.00

Priority 1 Electronics is pleased to offer the COMPUPRO DISK 1 High Performance Disk Controller at our regular low price with CP/M 2.2 and BIOS at no additional cost. That's a savings of $220.00 of the manufacturer's list price.

- Third generation INTEL 8272/NEC 765A LSI floppy disk controller.
- High speed cycle stealing DMA interface for processor independent data transfer between system memory and flexible disk.
- Handles up to four 8 or 5.25 inch floppy disk drives
- Single or double density/single or double sided capability.
- Supports IBM 3740 soft sectored formats.
- 24 bit DMA addressing with data transfer across 64K boundaries for data transfer throughout the 16Mbyte memory map.

PART NO.	DESCRIPTION	LIST PRICE	OUR PRICE
BEPDB171ACPM	A&Tw/CP/M 2.2 & BIOS	$670.00	$450.00
BEGBT171C	CSC	$595.00	$555.00
BEGBTCPM80*	CP/M 2.2 for Z80/8085 with manuals & BIOS 8" S/D disk		$175.00
BEGBTOAS8S	Oasis 8 bit single user 8" S/D disk		$500.00
BEGBTOAS8M	Oasis 8 bit multiuser, 8" S/D disk		$850.00

S-100 SYSTEMS

SUPERSIXTEEN — COMPUPRO

HERE IS WHAT EACH PACKAGE INCLUDES:

BEGBT1612A 6 MHz 8085/8088 Dual Processor Board
BEGBT171A High Speed DMA Disk Controller
BEGBT162A System Support 1 Multi-Function Board
BEGBT133A Interfacer 1 Dual Serial I/O
BE 128K 10MHz Low Power Static Ram
BEGBTCP/M 88 16 Bit Operating System Ready to Load & Go
Cables and Documentation Three interfacer cables one disk I/O cable, complete documentator for all hardware, and manuals for both CP/M operating systems.
Compu Pro's famous **1 Year** limited warranty.

Now to the best part of all. If purchased separately, these quality components would list for $4,344.00. **BUT SuperSixteen's low package price is an amazing $3,495.00. You save $849.00!** (For boards qualified under the Certified System Component high-reliability program - with extended 2 year warranty, 200 hour burn-in and 6/8 MHz processors - add $600.00 to the package price. Sh. Wt. 15 lbs.

BEPDBGBTSJ	SuperSixteen A&T	$3495.00
BEPDBGBTSK	SuperSixteen CSC	$4095.00

PRINTERS



MICROLINE — OKIDATA WITH FRICTION AND TRACTOR FEED

- BI-DIRECTIONAL - 120 CPS
- 9x9 Matrix (Alphanumeric)
- 6x9 or 12 Matrix for Graphics
- 5,8.3, 10,16 Charactrsp/Inch
- 6 or 8 Lines per Inch
- 80 CPL@ 10 CPI for 82A
- 132 CPL@10 CPI for 83A
- Parallel and Serial I/O
- 100 Thru 1200 Baud
- Self Test
- Out of Paper Switch
- Friction or Tractor Feed
- 3" to 14" Top of Form (Switch Selectable)
- 10 Different Character Sets

PART NO.	DESCRIPTION	LIST PRICE	SALE PRICE
BEOKIDAT82AT (26 lbs)	8 80 CPL @ 10 CPI	$ 799.00	$ 39.00
BEOKIDAT83AT (37 lbs)	132 CPL @ 10 CPI	$1195.00	$750.00
BEOKISER2KBF	9600 baud with 2K Serial Buffer upgrade with X-on Y-off		$159.00
BEOKIGRAPH	High Resolution Graphics Prom		$99.00

CALL FOR THE NEW MICROLINE 84

MX80 — EPSON NEED WE SAY MORE?

BEEPNMX80	Tractor Feed 17 lbs	$645.00	$450.00
BEEPNMX100	132 Col. Tractor Feed 24 lbs		$725.00

PRINTER INTERFACES - MICROBYTE

BEMBSSEI1	RS232 Serial Conversion for MX80 A & T	$55.00
BEMBSAEI1	Apple Centronics 8 bit parallel interface for Centronics, Epson & OKIDATA printers A & T	$55.00
BEMBSAEC1	Cable for above	$14.95

Printer interfaces & cables sold only with printer purchase

S-100 MAINFRAMES



S-100 MICROFRAME - TEI

110V 60HZ CVT Mainframes, the best money can buy!
12 Slot ±8V 17A±16V @ 2A
22 Slot ±8V @ 30A± 16V @ 4A

PART NO.		LIST PRICE	OUR PRICE 1-9	10-24
BETEIMCS 112	12 Slot Desk	$685.00	$615.00	$570.00
BETEIMCS 122	22 Slot Desk	$825.00	$760.00	$705.00
BETEIRM 12	12 Slot Rackmount	$725.00	$720.00	$619.00
BETEIRM 22	22 Slot Rackmount	$875.00	$850.00	$750.00

Shipping Weight: On 12 Slot Mainframe 45 lbs. On 22 Slot Mainframes 55 lbs.

TEI S-100 FRAMES 3 - 5" DISK CUTOUTS

±8V @ 17±16V @ 1.2A, Internal Cables

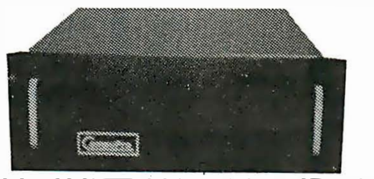
			1-9	10-24
BETEITF12	12 Slot desk	$675.00	$625.00	$580.00
BETEIRF12	12 Slot Rackmount	$795.00	$715.00	$685.00

Shipping Weight: On 12 Slot Desk 40 lbs. On 12 Slot Rackmount 45 lbs.

DUAL 8" DISK DRIVE CHASSIS - TEI

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			1-9	10-24
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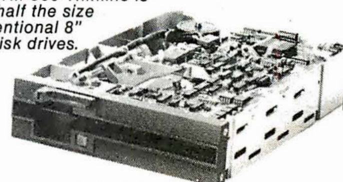
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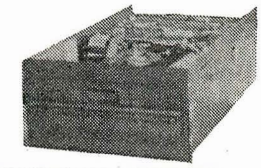
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BETNDTM8M	Manual - not included with drive		$ 10.00

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*As used in the IBM P.C.

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- Drives pull out for easy service and maintenance

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2716-1	2048 x 8	(5V) (350ns)	9.00	8.50
TMS2716	2048 x 8	(450ns)	9.95	8.95
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2732	4096 x 8	(5V) (450ns) (200ns)		CALL
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				100 pcs
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4116-120	16,384 x 1	(120ns)	8/29.95	CALL
4116-150	16,384 x 1	(150ns)	8/18.95	1.95
4116-200	16,384 x 1	(200ns)	8/15.95	1.80
4116-300	16,384 x 1	(300ns)	8/14.95	1.75
4164	64,536 x 1	(200ns)		CALL

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				100 pcs
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2102-1	1024 x 1	(450ns)	.89	.85
21L02-4	1024 x 1	(LP) (450ns)	1.29	1.15
21L02-2	1024 x 1	(LP) (250ns)	1.69	1.55
2111	256 x 4	(450ns)	2.99	2.49
2112	256 x 4	(450ns)	2.99	2.79
2114	1024 x 4	(450ns)	8/16.95	1.95
2114L-2	1024 x 4	(LP) (200ns)	8/19.95	2.35
2114L-3	1024 x 4	(LP) (300ns)	8/18.95	2.25
2114L-4	1024 x 4	(LP) (450ns)	8/17.95	2.10
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TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMS40L44-2	4096 x 1	(LP) (200ns)	4.49	4.25
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3.579545	3.95
4.0	3.95
5.0	3.95
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5.185	3.95
5.7143	3.95
6.5536	3.95
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10.0	3.95
14.31818	3.95
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18.432	3.95
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RS232	**HOOD**	**.99**

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6522	9.95
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6551	11.85

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74LS01	.25	74LS86	.40	74LS169	1.75	74LS298	1.20
74LS02	.25	74LS90	.65	74LS170	1.75	74LS324	1.75
74LS03	.25	74LS91	.89	74LS173	.80	74LS352	1.55
74LS04	.25	74LS92	.70	74LS174	.95	74LS353	1.55
74LS05	.25	74LS93	.65	74LS175	.95	74LS363	1.35
74LS08	.35	74LS95	.85	74LS181	2.15	74LS364	1.95
74LS10	.25	74LS96	.95	74LS189	9.95	74LS365	.95
74LS11	.35	74LS107	.40	74LS190	1.00	74LS366	.95
74LS12	.35	74LS109	.40	74LS191	1.00	74LS367	.70
74LS13	.45	74LS112	.45	74LS192	.85	74LS368	.70
74LS14	1.00	74LS113	.45	74LS193	.95	74LS373	.99
74LS15	.35	74LS114	.50	74LS194	1.00	74LS374	1.75
74LS20	.25	74LS122	.45	74LS195	.95	74LS377	1.45
74LS21	.35	74LS123	.95	74LS196	.85	74LS378	1.18
74LS22	.25	74LS124	2.99	74LS197	.85	74LS379	1.35
74LS26	.35	74LS125	.95	74LS221	1.20	74LS385	1.90
74LS27	.35	74LS126	.85	74LS240	.99	74LS386	.65
74LS28	.35	74LS132	.75	74LS241	.99	74LS390	1.90
74LS30	.25	74LS136	.55	74LS242	1.85	74LS393	1.90
74LS32	.35	74LS137	.99	74LS243	1.85	74LS395	1.65
74LS33	.55	74LS138	.75	74LS244	.99	74LS399	1.70
74LS37	.55	74LS139	.75	74LS245	1.90	74LS424	2.95
74LS38	.35	74LS145	1.20	74LS247	.76	74LS447	.37
74LS40	.35	74LS147	2.49	74LS248	1.25	74LS490	1.95
74LS42	.55	74LS148	1.35	74LS249	.99	74LS668	1.69
74LS47	.75	74LS151	.75	74LS251	1.30	74LS669	1.89
74LS48	.75	74LS153	.75	74LS253	.85	74LS670	2.20
74LS49	.75	74LS154	2.35	74LS257	.85	74LS674	9.65
74LS51	.25	74LS155	1.15	74LS258	.85	74LS682	3.20
74LS54	.35	74LS156	.95	74LS259	2.85	74LS683	2.30
74LS55	.35	74LS157	.75	74LS260	.65	74LS684	2.40
74LS63	1.25	74LS158	.75	74LS266	.55	74LS685	2.40
74LS73	.40	74LS160	.90	74LS273	1.65	74LS688	2.40
74LS74	.45	74LS161	.95	74LS275	3.35	74LS689	2.40
74LS75	.50	74LS162	.95	74LS279	.55	81LS95	1.69
74LS76	.40	74LS163	.95	74LS280	1.98	81LS96	1.69
74LS78	.50	74LS164	.95	74LS283	1.00	81LS97	1.69
74LS83	.75	74LS165	.95	74LS290	1.25	81LS98	1.69

CMOS

74C00	.35	74C374	2.75	4019	.45	4098	2.49
74C02	.35	74C901	.80	4020	.95	4099	1.95
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74C10	.35	74C905	10.95	4023	.35	14411	11.95
74C14	1.50	74C906	.95	4024	.75	14412	12.95
74C20	.35	74C907	1.00	4025	.35	14419	4.95
74C30	.35	74C908	2.00	4026	1.65	4502	.95
74C32	.50	74C909	2.75	4027	.65	4503	.65
74C42	1.75	74C910	9.95	4028	.80	4508	1.95
74C48	2.10	74C911	10.00	4029	.95	4510	.95
74C73	.65	74C912	10.00	4030	.45	4511	.95
74C74	.85	74C914	1.95	4034	2.95	4512	.95
74C76	.80	74C915	2.00	4035	.85	4514	1.25
74C83	1.95	74C918	2.75	4040	.95	4515	2.25
74C85	1.95	74C920	17.95	4041	1.25	4516	1.55
74C86	.95	74C921	15.95	4042	.75	4518	1.25
74C89	4.50	74C922	5.95	4043	.85	4519	1.25
74C90	1.75	74C923	5.95	4044	.85	4520	1.25
74C93	1.75	74C925	6.75	4046	.95	4522	1.25
74C95	1.75	74C926	7.95	4047	.95	4526	1.25
74C107	1.00	74C927	7.95	4049	.55	4527	1.95
74C150	5.75	74C928	7.95	4050	.55	4528	1.25
74C151	2.25	74C929	19.95	4051	.95	4531	.95
74C154	3.25	74C930	19.95	4053	.95	4532	1.95
74C157	1.75	4000	.35	4060	1.45	4538	1.95
74C160	2.00	4001	.35	4066	.75	4539	1.95
74C161	2.00	4002	.25	4068	.40	4543	2.70
74C162	2.00	4006	.95	4069	.35	4555	.95
76C163	2.00	4007	.29	4070	.35	4556	.95
74C164	2.00	4008	.95	4071	.30	4581	1.95
74C165	2.00	4009	.45	4072	.30	4582	1.95
74C173	2.00	4010	.45	4073	.30	4584	.95
74C174	2.25	4011	.35	4075	.30	4585	.95
74C175	2.25	4012	.25	4076	.95	4702	12.95
74C192	2.25	4013	.45	4078	.30	4724	1.50
74C193	2.25	4014	.95	4081	.30	80C07	.95
74C195	2.25	4015	.95	4082	.30	80C95	.85
74C200	5.75	4016	.45	4085	.95	80C96	.95
74C221	2.25	4017	1.15	4086	.95	80C97	.95
74C373	2.75	4018	.95	4093	.95	80C98	1.20

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8228	4.90
8237	19.95
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8250	14.95
8251	4.75
8253	9.25
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8255	4.75
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8257	8.75
8259	6.90
8272	39.95
8275	29.95
8279	9.50
8279-5	10.50
8282	6.65
8283	6.65
8284	5.70
8286	6.65
8287	6.50
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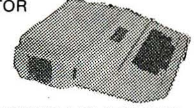
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	1-99	100
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14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39

ST = SOLDERTAIL

8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
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WW = WIREWRAP

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Jumbo Red	10/1.00
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5082-7760 .43'CC	.79
MAN74 .3'CC	.99
MAN72 .3'CA	.99

VOLTAGE REG's

7805T	.79	7905T	.89
7808T	.99	7912T	.89
7812T	.79	7915T	1.19
7815T	.99	7924T	1.19
7824T	.99		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	79LO5	.79
78LO5	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69		
		LM317K	3.95
LM309K	1.49	LM323K	4.95
LM317T	1.95	LM337K	3.95

T = TO-220 K = TO-3 L = TO-92

LINEAR

LM301V	.34
LM308V	.98
LM309K	1.49
LM311	.64
LM317T	1.95
LM317K	3.95
LM318	1.49
LM323K	4.95
LM324	.59
LM337K	3.95
LM339	.99
LM377	2.29
LM380	1.29
LM386V	1.50
LM555V	.39
LM556	.69
LM565	.99
LM566V	1.49
LM567V	1.29
LM723	.49
LM733	.98
LM741V	.29
LM747	.79
LM748V	.59
LM1310	2.90
MC1330V	1.89
MC1350V	1.29
MC1358	1.79
LM1414	1.59
LM1458V	.69
LM1488	.99
LM1489	.99
LM1800	2.99
LM1889	2.49
LM3900	.59
LM3909V	.98
LM3914	3.95
LM3915	3.95
LM3916	3.95
75451V	.39
75452V	.39
75453V	.39

7400 SERIES

7400	.19	7451	.23	74136	.50	74186	18.50
7401	.19	7453	.23	74141	.65	74190	1.15
7402	.19	7454	.23	74142	2.95	74191	1.15
7403	.19	7460	.23	74143	2.95	74192	.79
7404	.19	7470	.35	74144	2.95	74193	.79
7405	.22	7472	.29	74145	.60	74194	.85
7406	.22	7473	.34	74147	1.75	74195	.85
7407	.22	7474	.35	74148	1.20	74196	.79
7408	.24	7475	.49	74150	1.35	74197	.75
7409	.19	7476	.35	74151	.65	74198	1.35
7410	.19	7480	.59	74152	.65	74199	1.35
7411	.25	7481	1.10	74153	.55	74221	1.35
7412	.30	7482	.95	74154	1.40	74246	1.35
7413	.35	7483	.50	74155	.75	74247	1.25
7414	.55	7485	.65	74156	.65	74248	1.85
7416	.25	7486	.35	74157	.55	74249	1.95
7417	.25	7489	4.95	74159	1.65	74251	.75
7420	.19	7490	.35	74160	.85	74259	2.25
7421	.35	7491	.40	74161	.70	74265	1.35
7422	.29	7492	.50	74162	.85	74273	1.95
7423	.29	7493	.49	74163	.85	74276	1.25
7425	.29	7494	.65	74164	.85	74279	.75
7426	.29	7495	.55	74165	.85	74283	2.00
7427	.29	7496	.70	74166	1.00	74284	3.75
7428	.45	7497	2.75	74167	2.95	74285	3.75
7430	.19	74100	1.00	74170	1.65	74290	.95
7432	.29	74107	.30	74172	5.95	74293	.75
7433	.45	74109	.45	74173	.75	74298	.85
7437	.29	74110	.45	74174	.89	74351	2.25
7438	.29	74111	.55	74175	.89	74365	.65
7440	.19	74116	1.55	74176	.89	74366	.65
7442	.49	74120	1.20	74177	.75	74367	.65
7443	.65	74121	.29	74178	1.15	74368	.65
7444	.69	74122	.45	74179	1.75	74376	2.20
7445	.69	74123	.55	74180	.75	74390	1.75
7446	.59	74125	.45	74181	2.25	74393	1.35
7447	.69	74126	.45	74182	.75	74425	3.15
7448	.69	74128	.55	74184	2.00	74426	.85
7450	.19	74132	.45	74185	2.00	74490	2.55

SHUGART SA-400

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Apple II 48K	1530 00	1099 00
Apple II 64K	1729 00	122500
Apple II 64K w/Z80 Softcard & Vision 80	2519 00	177500
★ Apple III 128K	349500	★ 289500

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APPLE HARDWARE

AVAILABLE IN STORE ONLY

	LIST	ACP
Apple Disk II w/interface	$ 64500	$ 52900
Apple Disk II w/o	52500	44900
Silentype Printer	39500	355 00
Prototype Card	24 00	21 95
IEEE-488 Interface	45000	37500
1 year ext warranty	22500	17500
Parallel Printer Interface	18000	15995
Communications Card	22500	18900
Pascal Language System	49500	42595
High Speed Serial Interface	195 00	17495
Applesoft II ROM Card	200 00	15995
Language Card	195 00	17495
12" Green Monitor III	320 00	27500
★ Profile Hard Disk Subsystem	3495 00	2995 00
Graphics Tablet	795 00	69500

APPLE COMPATIBLE HARDWARE

Microsoft Z80 Softcard©		$249 00
Microsoft 16K RAMcard©		129 00
SSM AIO Serial/Parallel		165 00
The Keyboard Company	Joystick	45 00
	Numeric Pad	119 00
Mountain Computer	ROMplus	169 00
	ROM Writer	159 00
	RAMPlus	call
	CPS Multifunction	16900
	Expansion Chassis	69900
	Thunderclock	12500
	X-10 option	4900
	Pascaloption	2900
Versacard 4 in 1		22500
CCS Serial I/O		13900
Parallel I/O		9900
M & R Enterprises	Apple Fan	45 00
	Sup'R Mod	2995
	Aux Switcher Supply	19900
	Sup'R Term	29900
ALS Smarterm		29900
Corvus	5Mb Hard Disk	2995 00
	10Mb	432500
	20Mb	524000
Apple 16K Upgrade Kit		1295
Votrax Voice Box		call
Scott Voice Recognition		call

APPLE SOFTWARE

Visicalc	$ 16900
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VisiTrend/VisiPlot	23900
VisiDex	16900
VisiTerm	12900
BPI General Ledger	32900
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Cobol 80	699 00
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PFS Report	75 00

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MPI B5-1-5 1/4", 40 tracks	279 00
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Shugart 800/801R 8"	449 00
Siemens Shugart Compatible Model FDD-120-8D	42900
PERSCI Model 277 Dual	1195 00
MPI B52 5 1/4" Dual	348 00
WANGO/SIEMENS 2	290 00
MPI 91 Double Track Density Single Side. 80 Tracks	37500
MPI 92 Double Track Density Double Side. 160 Track	475 00

16K RAMCARD



- Apple II compatible

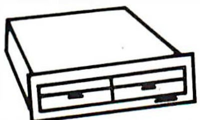
List $195.00 ACP $74.95

DEALER PRICING AVAILABLE

Vista

VISTA COMPUTER

	LIST	ACP
★ Vision 80 © 80x24 display card	$395 00	$299 00
Vision 40 © 40 col enhancement	199 00	14900
Vision 20 © lower case ROM	2995	2500
★ A800 Double Density 8" Controllers	59500	★ 499 00
MM9 9 voice music	19500	99 00
GB75 IBM Regent/Apple I/O	19500	16900
PDS PROM development	59500	39900
TYPE AHEAD BUFFER	4995	3500



Vision 80 $299.00

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VISTA V-DRIVE
Model V-1000 8" floppy disk enclosures with Qume Datatrak 8

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w/2 single-sided drives. ps&c	$1495 00
w/2 double-sided drives. ps&c	$1995 00
A800 Double density controller (for Apple computers)	$ 499 00

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D/S. D/D also available

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DOS software not included

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A2C controller	100.00	89.00
A405 1/4" 160K Drive	449.00	365.00
A705 1/4" 286K Drive	599.00	480.00
A40C controller for A40/A70	100.00	79.00

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525-10	10 Hole Hard NS Apple etc	$29.95
525-16	16 Hole Hard Micropolis	$29.95
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577-01	Soft Sectored TRS 80 etc	$32.25
577-10	10 Hole Hard NS Apple etc	32.25
577-16	16 Hole Hard Micropolis	32.25
• 40 TRACKS. DOUBLE SIDED. DOUBLE DENSITY 5¼		
550-01	Soft Sectored SA 450 MPI 52	$39.95
550-10	10 Hole Hard BASF WANGCO	$39.95
550-16	16 Hole Hard Micro²	$39.95
• 8" 100% CERTIFIED DISKETTES		
FD800-01	Soft Single Density 3740	$33.50
FD800-32	32 Hard Single Density Shug	33.50
FD802-01	Soft Double Density 3740	44.80
FD850-01	Soft Double Sided Double Density 3740	49.80

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- Artificial Inteligence Experiments
- Computer Art and Games



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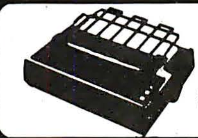
Microbot Minimover-5	
Completely Assembled w/Applications Manual	$1695 00
ARMBASIC Software For TRS-80	39 95
Application/Reference Manual	16 95

USI INTERNATIONAL — USI Computer Products



VIDEO MONITOR
(Sanyo Look Alike)

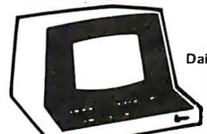
Model Pi 1 9" Green	$159.95
Model Pi 2 12" Green	159.95
Model Pi 3 12" Orange	199.95



$429.00

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EPSON/VISTA			
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★ MX-80/FT		74500	52900
MX-100		999 00	72500
Apple I/O & cable		110 00	8900
Graftrax option		9500	8900
IEEE I/O & cable		13000	9500
Serial I/O & cable		13000	9500
Serial w/2K & cable		17500	14900
Universal Graphics Utility		3995	★ 3595
NEC			
8023 Dot Matrix		79500	64900
DIABLO			
★ 630 Daisywheel		2965 00	★ 229500
Tractor		249 00	16995
C. ITOH/VISTA			
★ Starwriter/V300	25 cps	189500	★ 149500
	45 cps	219500	179500
8510	100 cps	749 00	★ 67500
ANADEX			
9500/9501		1650 00	135000
QUME			
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IDS			
460G w/graphics		1395 00	899 00
560G 14.75" carriage		1695 00	119900



BROTHER Daisywheel Printer Only $895

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910	$ 69900	$ 59900
912C	95000	69900
920C	995 00	799 00
950C	1195 00	99900
SOROC		
IQ120		699 00
IQ135		899 00
IQ140		1149 00

SANYO

MONITORS

SANYO	LIST	ACP
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9" Green	259 00	199 95
12" B&W	340 00	249 00
12" Green	360 00	279 00
13" Color	550 00	429 00
13" RGB	1195 00	995 00

Novation

MODEMS

	LIST	ACP
NOVATION		
Cat	$19995	$14900
D-Cat	19995	16900
Apple-Cat	34995	30900
Auto-Cat	29995	23995
HAYES		
Micromodem	$379 00	$299 00
Smartmodem	279 00	249 00

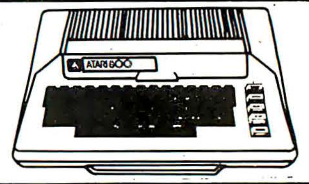
IBM

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MAX-OUT YOUR IBM PC

Vista 576K RAM CARD	
256K populated	$1199.00
512K populated	173900
576K populated	184900
Vista 192K ADD-ON w/SUPERCALC WOW! Superdeal @ That's for both	799 00
IBM Wire Wrap Board	69.00
IBM Extender Board	19.95



ATARI

ATARI COMPUTER

	LIST	ACP
400 w/16K RAM	$399 00	$339 95
400 Basic Language Module	4900	47 00
800 w/16K RAM	899 00	69900
410 Prog Recorder	9000	80 00
825 Printer	799 95	699 00
830 Acoustic Modem	199 95	15900
850 Interface Module	21995	18995
MTK 16K RAM	9950	7400
MTK 32K RAM	199 50	13900
ATARI VisiCalc	20000	160 00
ATARI Pac-Man	4495	3695

ADD-ON MEMORY



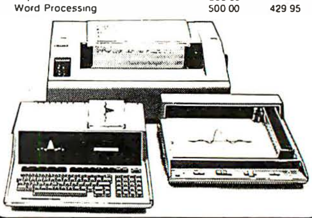
	LIST	ACP
Atari 16K	$ 99.50	$ 74.00
Atari 32K	199.00	139.00
Vic 20 16K	199.50	149.00

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★ 820-2	8" system	3795 00	★ 3195 00
CP/M		200 00	169 95
SuperCalc		295 00	239 95
Word Processing		500 00	429 95



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HEWLETT-PACKARD COMPUTERS

★ New

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HP-85A	2750.00	2095 00
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HP-125	2750.00	2095.00
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9135A 51/4" Floppy w/Winchester		476500
9895A 8" Dual Floppy		5135.00
7470A Plotter		1375 00
82907A 32K Module		24900
82908A 64K Module		37900
82909A 128K Module		67500
82900A CP/M w/64K		425.00

CALCULATORS

		LIST	ACP
HP-41CV w/2.2K memory	NEW!	325.00	256 00
HP-41C Calculator		25000	18995
Memory Module for 41C			2600
Quad RAM		9500	8395
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Printer for 41C. CV		38500	29195
Optical Wand for 41C, CV		125 00	9995
HP-11C Advanced Scientific	★ NEW!	135 00	14995
HP-12C Financial		15000	129 95
HP-34C Prog Scientific		15000	119 00
HP-38C Prog Business		15000	119 00
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16K Ramcard	195.00	169 00
Vision 80 display card (Vista)	395 00	299 00

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Floppy Disk Power Supply
Drives 2 Drives
+24V @ 3A +5V @ 2.5A -5V @ 0.5A

LIST	ACP
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ACP
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- Compatible with Z-80 Softcard™
- Allows system to run with CP/M™, PASCAL, DOS 3.3, COBAL, Visicalc, etc.
- Supplied with extra 16K RAM & has (2) LED's

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2 or 4 MHz
Expandable
Uses 2114L's

16K 4 MHz Kit	$159.95
16K 4 MHz A&T	217.95
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Bare Bdw/allparts less mem.	99.95

BARE BOARDS

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for COLOR & B/W

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29¢ ea.

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PMI "Super Beta" LOW POWER AMPLIFIER

INTERNALLY COMPENSATED
P/N OP12GJ

Voffset = 1.0 mV
Ibias = 5.0mA
Gain = 40V/mV
(quantity limited)

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ACP $1.95

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$79.95
Holds 4 EPROM's at a time.

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16K Memory Expansion Kits for Apple/TRS-80

8 pcs 4116 16K
200/250nS
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with TINY BASIC
Debug prog. $49.95
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Unreal price. DB37 male, DB25 female. Gold PC mount with mounting holes. Mfg. AMP. Specify 25 or 37 pins.

BD37 $2.50 DB25 $1.95

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USED IN DATA PRODUCTS PRINTER
$19.95 ea.

CONNECTORS

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DB25S Female	3.75
Hood	1.25
Set with Hood, Sale	7.50
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50/100 S-100 Connector W/W	4.95
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2" DIAMETER
ALL METAL
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Full ASCII Encoded Keyboards

RCA 128-Character, 58-Key Typewriter Format for Alphanumeric Entry

VP-608 Async serial output. Reg. $99.00
ACP SALE ... $69.95

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PNP power
HFE = 40-120
VCEO = 30
IC = 3A
6,000 pcs available
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2101	3.99	1103	.99	6561	3.79
2102	.79	4027	4.69	6604	3.99
21L02-2	1.49	4044	3.99	6805	7.99
21L02-4	1.29	4050	4.69	9130	8.99
2111	3.49	4060	4.69	9140	8.99
2112	3.49	4096	3.99	93415	6.99
2114	1.99	4115	1.49	93425	6.99
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2114L-4	2.29	4402	1.99		
2125	6.99	5280	4.60		

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8156	9.95	8275	19.95	68488	19.95
8202	29.95	8279	9.50	46505	22.95
8205	2.69	6810	4.75	6520	6.95
8212	2.75	6820	6.50	6522	9.95
8214	4.95	6821	6.50	6530-X	24.95
8216	2.75	6828	10.50	6532	17.95
8224	2.95	6834	16.95	6551	19.95
8226	2.95	6845	22.95	Z80-PIO	6.50
8228	3.95	6847	27.95	Z80A-PIO	9.50
8243	9.50	6850	5.25	Z80-CTC	6.50
8250	14.95	6852	5.25	Z80A-CTC	9.50
8251	6.50	6860	10.95	Z80-DMA	19.95
8253	11.95	6862	10.95	Z80A-DMA	27.95
8255	4.50	6875	5.95	Z80-SIO	24.95
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MOS PROMS

2764 (8Kx8) TS	$69.95	2708 (450nS)	$5.75
2732 (4Kx8) TS	12.95	2708 (650nS)	5.25
2716/2516: 5V (2Kx8) TS	7.95	1702A	5.75
TMS2716, 5V, 12V	17.95	MM5203AQ	14.50
2758, 5V, (450nS)	3.50	MM5204Q	9.95

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2513-001 (5V) Upper	$9.50	DAC08	$9.95
2513-005 (5V) Lower	10.95	DAC100	9.95
2513-ADM3 (5V) Lower	14.95	8038 Function Generator	4.50
MCM66710 ASCII Shifted	12.95	MC4024VCO	2.95
MCM66740 Math Symbol	13.95	LM566 VCO	1.95
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DAC01 D to A	5.95	MM5740AAC	8.95

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	1-24	25-49	50-100
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14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.29	.27	.24
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
40 pin LP	.60	.59	.58

3L WIREWRAP SOCKETS (GOLD)

	1-24	25-49	50-100
8 pin WW	.55	.54	.49
10 pin WW (Tin)	.65	.83	.58
14 pin WW	.75	.73	.67
16 pin WW	.80	.77	.70
18 pin WW	.95	.90	.81
20 pin WW	1.15	1.08	.99
22 pin WW	1.45	1.35	1.23
24 pin WW	1.35	1.26	1.14
28 pin WW	1.60	1.53	1.38
40 pin WW	2.20	2.09	1.89

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78M06	1.49	LM1458CN/N	.49
78M.G.	1.49	MC1488N	.99
LM108AH	2.95	MC1489N	.99
LM300H	.99	LM1496N	.89
LM301CN	.35	LM1556N	1.50
LM304H	1.98	LM1820N	.95
LM305H	1.89	LM1850N	.95
LM306H	3.25	LM1889N	3.10
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LM308CN	.98	LM2900N	.99
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LM311D/CN	.89	CA3013T	2.19
LM312H	1.75	CA3018T	1.99
LM317T	1.70	CA3021T	3.49
LM318CN	1.49	CA3023T	2.99
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.35	CA3039T	1.29
LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	LM3053N	1.49
LM323K	4.95	CA3059N	3.19
LM324N	.95	CA3060N	3.19
LM337K	5.95	CA3062N	4.95
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LM348N	1.20	CA3089N	2.99
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LM360N	1.49	CA3130T	1.30
LM372N	1.95	CA3140T	1.19
LM376N	3.75	CA3146N	2.49
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LM739N	1.15	SN75452N	.49
LM741CN/H	.33	SN75453N	.49
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LM747N/H	.75	SN75491N	.89
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74S05	.52	74S136	1.69	74S258	1.29
74S08	.49	74S138	1.29	74S260	.75
74S09	.49	74S139	1.29	74S280	2.79
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74S15	.42	74S153	1.29	74S373	3.10
74S20	.42	74S157	1.29	74S374	3.10
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74S65	.46	74S196	1.89	74S571	5.75
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7406	.35	7485	.65	74167	1.95
7407	.35	7486	.35	74170	1.69
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
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7447	.65	74150	1.09	74283	1.40
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7450	.19	74152	.67	74285	3.90
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7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
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74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	.28	74LS125	.89	74LS253	1.40
74LS08	.28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
74LS10	.28	74LS136	.49	74LS259	2.95
74LS11	.39	74LS138	.85	74LS260	.65
74LS12	.33	74LS139	.85	74LS261	2.49
74LS13	.47	74LS145	1.25	74LS266	.59
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74LS15	.33	74LS151	.79	74LS275	4.40
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74LS30	.26	74LS160	1.05	74LS324	1.75
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74LS33	.55	74LS162	1.05	74LS348	1.95
74LS37	.45	74LS163	1.05	74LS352	1.19
74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
74LS47	.79	74LS168	1.15	74LS366	.69
74LS48	.95	74LS169	1.15	74LS367	.69
74LS51	.26	74LS170	1.99	74LS368	.69
74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
74LS73	.45	74LS175	.89	74LS375	.69
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74LS76	.45	74LS191	1.15	74LS386	.65
74LS78	.45	74LS192	.98	74LS390	1.95
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74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	.95	74LS399	2.35
74LS90	.57	74LS196	.89	74LS424	2.95
74LS92	.75	74LS197	.89	74LS668	1.75
74LS93	.75	74LS221	1.15	74LS670	2.29
74LS95	.88	74LS240	1.69	81LS95	1.69
74LS96	.98	74LS242	1.69	81LS96	1.69
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4021	1.19	4068	.75	4510	1.19
4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
4029	1.29	4076	1.29	4555	4.95
4030	.45	4077	.35	4556	.99
4031	3.25	4078	.35	4566	2.25
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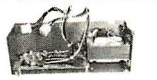
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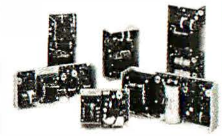


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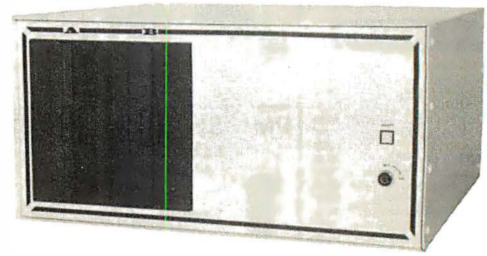
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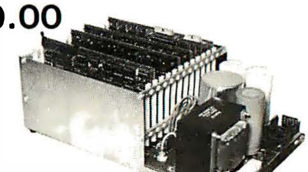
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• +8VDC at 30Amps	+24 at 4 Amps
• ±16VDC at 6 Amps	−5 at 1 Amp

XOR-CPU	Z-80 4MHZ, Prom 2 Serial 3 Par	**$255**
XOR-DSK	WD-1795 MINI and 8"	**$275**
XOR-64K	Bank SW Memory up to 1 Meg	**$389**
XOR-32K	Static Ram (Kit)	**$199**
XOR-MPM	IO MPM Interface Card	**$335**
XOR-DTC	Hard Disk and DTC Tape	**$225**
XOR-SMS	Hard Disk Controller	**$750**

★ MODEMS ★

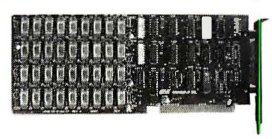


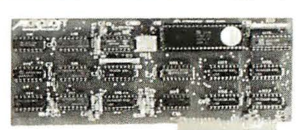
Ask About Our Low Cost Modem Software



Hayes - Micro Modem	**$275.00**
Hayes - Smart Modem	**$250.00**
NOV. - DCAT 300 Baud Direct Con. Ans./Orig.	**$165.00**
NOV. - AUTOCAT Auto/Ans./Orig. Direct Con.	**$235.00**
NOV. - APPLECAT 300/1200 Baud Direct Con.	**$350.00**
PMMI - MM103 300/600 Baud (S-100)	**$359.00**

★ IBM AND APPLE ★





APPLE - 16K Ram Expansion Card, works with Microsoft Basic	**$99.50**
APPLE - Z-80 CPU Direct replacement for Z-80 Softcard	**$149.50**
IBM-PC Ram Expansion Card with 64K (256K available	**$475.00**

Circle 419 on inquiry card.

California Computer Systems

- 2810 CPU — Only — $255.00
- 2422 Dsk Cont — Only — $330.00
- 2065C 64K — Only — $510.00
- 2200A Mainframe — Only — $450.00
- CCS Apple Boards — Call for prices
- CCS 2200 System Tested and Assembled — Only — $1,695.00

★ SPECIAL ★ SPECIAL ★ SPECIAL ★

CCS SYSTEM 2410

FEATURES

* DMA Disk Controller
* 2-Real Time Clocks
* 2-Serial/1-Parrell Port
* Hardware Vectored Interupts
* Supports C/PM, M/PM, OASIS

*****Comes with C/PM*****
only-$2200.00

SSM

Item	Price
CB2-CPU	$295.00
MB10A-16K	$295.00
MB64-64K	$845.00
I/05-2SER 3PAR	$329.00
I/O8-8SER	$550.00
Apple	
A-I/O II	$225.00
A-SI/O	$149.00
COMMUNICATIONS PACKAGES	
TRACEND I	$89.00
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FEATURES!

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- Feather Touch Capacitance Keyboard
- 60 Key Standard ASCII
  PLUS + Hex Keypad
  PLUS + 8 Special Function Keys
  PLUS + 20 Screen Editing Keys
- SOROC Type Screen Attribute Set
- Half Intensity

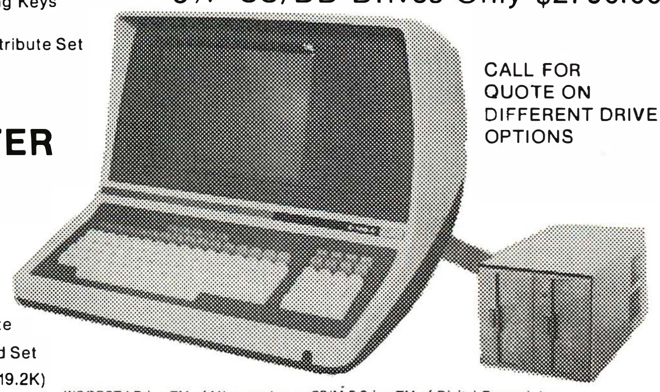
COMPUTER

- 8 Slot S-100
- 64K Dynamic Ram
- 4MHZ Z-80
- Double Density Disk Controller
- Programmable Baud Rate
- Programmable Keyboard Set
- Serial Printer Port (150-19.2K)

S-100-8

INCLUDING CP/M 2.2®
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WITH: 8" SS/DD Drives Only $2850.00
5¼" SS/DD Drives Only $2700.00



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MONITORS

ZENITH VIDEO MONITOR—
ZVM $145.00

AMDEK MONITORS—
AMDEK Color 1 .... $399.00
AMDEK Video 300 .... $229.00
w/Green Screen

DISK DRIVES

- Shugart 801's — $395.00
- Shugart 851's — $575.00
- Qume DT-8's — $540.00
- Shugart 400's — $255.00
- Tandom 5¼ — $255.00

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- Televideo 910 — $575.00
- Televideo 912C — $665.00
- Televideo 925C — $740.00
- Televideo 950 — $950.00
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- C-ITOH PROWRITER $625.00
- C-ITOH Comet I 9 x 7 Dot Matrix $450.00
- C-ITOH Comet II .... $810.00 132 Column Printer 9 x7 Dot Matrix
- MPI-88G $725.00
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- EPSON MX 100 .... CALL
- Anadex 9501 .... $1,235.00 Graphic Printer
- OKIDATA 82A $465.00
- Microline 80 .... $329.00

WE HAVE NEC SPINWRITERS
CALL FOR PRICES

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Apple 8" Disk Controller Card

- ZVX4 Dual Density, Single & Double Sided - Auto Boot $395.00
- Disk 2 + 2 Single Density Single or Dual Sided $300.00

UTIC

MINI STEREO FM RECEIVER WITH HEADPHONES



For Joggers, Cyclists, and Skaters!

FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case & shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl.). Compact size: 3⅞" x 4⅞" x 1". Wt. 6 oz.

Model 1810 List Price $89.95 .... **$29.95**

SPEAKERS





	1	2-9
Part# A0201	1.25	.99

2¼" Round — 8 Ohm
.25 Watt (4" Leads)
Size: 2¼" x ¾"

	1	2-9
Part# SF-25016	1.39	1.25

2½" Square — 16 Ohm
.25 Watt (4 mount. holes)
Large Ceramic Magnet
Size: 2⅝" x 2⅝" x ¾"



National Semiconductor

RAM SALE

STATIC RAMS

MM2114N-2 4K (200NS) .... $2.49 each
(8 EACH $10.95/lot) (100 EACH $195.95/lot)

MM2114N-2L 4K (200NS) Low Power .... $2.95 each
(8 EACH $10.95/lot) (100 EACH $225.00/lot)

MM2147N 4K (70NS) .... $4.95 each
(8 EACH $34.95/lot) (100 EACH $419.95/lot)

MM6116P-4 16K (200NS) .... $14.95 each
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

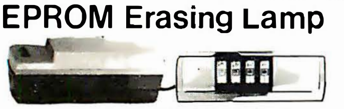
DYNAMIC RAMS

MM4164N-20 64K (200NS) .... $14.95 each
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

MM5290N-2 16K (150NS) 4116 .... $2.95 each
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM5290N-4 16K (250NS) 4116 .... $1.95 each
(8 EACH $14.95/lot) (100 each $175.00/lot)

EPROM Erasing Lamp



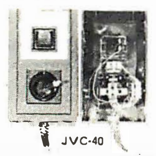
- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11EL Replacement Bulb $16.95

UVS-11E $79.95

JOYSTICKS





JS-5K	5K Linear Taper Pots	$6.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case . . .	$4.95

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The dependable, low cost, largest selling fan for commercial cooling applications.

- 105cfm free air delivery
- 4.68" sq. x 1.50" depth. Weight - 17 oz.
- acoustical rating as low as NC-38
- more than 10 yrs. cont. duty at 10°C
- impedance protected
- for ambients to 70°C
- UL yellow card recognized & CSA approved

115V, 50/60Hz, 14 Watts, 105cfm — Ultrasonically cleaned & tested.

MU2A1 .... $9.95 ea.

NEW!

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.



FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC Input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp) . .	$14.95
JE205 Adapter Brd. (to JE200) ±5,±9 & ±12V.	$12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

Part	Description	Price
INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

Part	Description	Price
MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Part	Description	Price
Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MC56502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95
1173AN-1	**30 Tune Musical MPU Chip**	**8.95**

SHIFT REGISTERS

Part	Description	Price
MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

Part	Description	Price
AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp.Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

Part	Description	Price
ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

RAM'S

Part	Description	Price
1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	2.25
2114L	1024x4 Static 450ns Low Power	2.49
2114-2	1024x4 Static 200ns	2.49
2114L-2	1024x4 Static 200ns Low Power	2.95
74S200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	1.95
4164N-3	64K Dynamic 200ns	14.95
MM2147N	4096x1 Fast 70ns	4.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.49
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	2.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	1.95
HM6116-4	16K (2Kx8) Static 200ns	14.95
82S25	64 Bit RAM (16x4OC)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

Part	Description	Price
1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	2.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716 Intel (2516) TI	16K EPROM (Single +5V)	8.95
2732 Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23 (74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123 (74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	16.95

— Over 30 More PROMS Listed In Our Catalog —

ROM'S

Part	Description	Price
2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

Part	Description	Price
MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

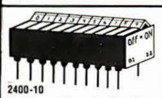
Part	Description	Price
M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

Part	Description	Price
DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

Part	Description	Price
AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95



2400-10

EECO Rocker DIP Switch — "Mini-Dip™" 2400 Series

THE MOST UNIQUE DIP SWITCH AVAILABLE!

MINI-DIP is designed to retrofit all major brands of Dip switches. Unique features include locking rod design to prevent accidental actuation and gold self-wiping contact. One-piece housing and press-fit terminals prevent contamination. 2-10 station Form "A" and 1-5 station Form "C." • Terminals on .100 x .300 (2.54 x 7.62) centers • PCB or dip socket mountable • Positive cleaning/wiping action with gold contact • Total seal and bottom seal

Part No.	Pos.	Configuration	Socket	Price
2400-2	2	12	8 pin	.79 - 10/ 6.95
2400-3	3	123	8 pin	.89 - 10/ 7.95
2400-4	4	1234	8 pin	.99 - 10/ 8.95
2400-ABCD	4	ABCD	8 pin	.99 - 10/ 8.95
2400-5C	6	C54321	14 pin	1.09 - 10/ 9.95
2400-6	6	123456	14 pin	1.09 - 10/ 9.95
2400-7	7	1234567	14 pin	1.19 - 10/10.95
2400-8	8	12345678	16 pin	1.29 - 10/11.95
2400-9	9	123456789	18 pin	1.39 - 10/12.95
2400-10	10	0123456789	20 pin	1.49 - 10/13.95

GRAB BAG SPECIALS



GB180 (Pictured Above)

CAPACITORS

Part No.	Description	Price
GB100	100 each Ceramic Disc (10pf–.1mf)	$2.00
GB101	60 each Mylar	4.00
GB102	60 each Electrolytics	4.00
GB103	40 each Tantalum (tubular & dipped)	4.00
GB176	40 each Dipped Micas (10pf-1000pf @ 100-500V)	4.00

INTEGRATED CIRCUITS

Part No.	Description	Price
GB108	50 each TTL Series — marked (7400, 74107, 74123, etc.)	$4.00
GB109	30 each Linear — marked (LM301, 307, 741, 308, etc.)	4.00
GB148	30 each Exar — marked (XR320, 1310, 4136, etc.)	4.00
GB150	20 each Shift Registers — marked (2510, 2518, 2532, 2533, etc.)	4.00
GB157	50 each DTL Series — marked (DM930, 932, 936, 946, etc.)	3.00
GB158	6 pcs. Positive Voltage Regulators (TO-3 case) (7805, 06, 12, 15, 18, 24, etc.) Linear marked	4.25
GB159	6 pcs. Negative Voltage Regulators (TO-3 case) (7905, 06, 12, 15, 18, 24, etc.) Linear marked	4.00
GB170	25 each Assorted 74LS TTL Series	4.00
GB172	10 pcs. 78M Positive Volt. Reg. (TO-5 case) (78M05, 8, 12, 15, 20, 24, etc.) Linear marked	5.00

LEDS – LAMPS – READOUTS

Part No.	Description	Price
GB110	100 each Assorted LEDs (colors & sizes) (XC556, XC526, etc.)	$8.00
GB111	40 each NE-2 Neon Type Lamps	3.00
GB112	20 ea. Multiple Readouts, calculators, sticks, timers, LEDS to Panaplex — new, used and rejects	4.00
GB162	50 each 7-Segment Displays (various colors and sizes)	5.00

POTENTIOMETERS

Part No.	Description	Price
GB113	30 each Miniature Trimmers (100 ohm-1 Meg)	$4.00
GB134	24 each 3/8" square single-turn PC Mount (untested — 10 ohm to 500 ohm) marked	3.00
GB135	24 each 3/8" square single-turn PC Mount (untested — 1K to 50K) marked	3.00
GB136	24 each 3/8" square single-turn PC Mount (untested — 100K to 5 Meg) marked	3.00
GB173	100 ea. 3/8" sq. single-turn (U Test & Sort)	5.00
GB174	25 ea. ¼ watt thumbwheel single-turn (500 ohm-5 Meg)	2.00

DIODES

Part No.	Description	Price
GB171	80 each Assorted Germanium (IN34, IN68, IN270)	$2.00
GB107	100 each Silicon (IN914/IN4148)	2.00
GB164	200 each marked, unmarked rectifiers & zeners	2.00
GB175	100 ea. 1 amp - 3 amp (cathode band) silicon rectifiers	3.00

RESISTORS

Part No.	Description	Price
GB116	200 each 1/4 watt resistor assortment	$2.00
GB117	200 each 1/2 watt resistor assortment	2.00
GB118	30 ea. Wire Wound 5,10,20W (.1-100 ohm)	4.00
GB154	100 each 1 and 2 watt resistor assortment	2.00
GB178	500 each 1/4, 1/2, 1 watt (marked/unmarked) resistors	4.00

SWITCHES

Part No.	Description	Price
GB120	25 each Miniature slide	$3.00
GB122	20 ea. Reed relays with coil and magnet — glass tube	5.00
GB165	40 asst. toggle, rocker, pushbutton	10.00
GB179	20 each Dip Switches (asst. positions)	9.95

HARDWARE

Part No.	Description	Price
GB139	40 each Terminal Strips solder and screw types (3 to 8 terminals)	$3.00
GB140	150 each Spacers, standoff, insulators (metal, nylon and plastic)	2.00
GB141	200 each Washers and Spacers (nylon and teflon)	2.00
GB142	50 ea. Chassis mounting feet (rubber and plastic)	2.00
GB144	200 each Solder lugs (small)	2.00
GB145	100 each Lugs — crimp on (some insulated)	2.00
GB146	100 each Grommets, cord strain reliefs and hole plugs	3.00
GB147	500 each Hardware mix (nuts, bolts, screws, lugs)	5.00
GB166	48 Threaded metal and plastic spacers (¼-2" long)	2.00
GB167	200 pcs. sheet metal and metal tapping screws	2.00
GB168	200 pcs. angle bkts, clip insulators, etc.	3.00
GB169	100 pcs. tie wraps and harness clips (3-6")	3.00
GB180	100 pcs. Robot/Slot Car gears, shafts, wheels, motors	9.95

MISCELLANEOUS

Part No.	Description	Price
GB123	30 each Heat Sinks — assorted sizes	$3.00
GB124	6 each assorted calculator-type keyboards	5.00
GB126	50 each Opto-Isolators — IL-1 Series (untested)	2.00
GB127	100 each Transistors — plastic and power	3.00
GB128	30 each Toroid Cores — iron and tape	4.00
GB129	50 each Photo Transistors (LPT)	4.00
GB130	1 each Tape Drive — 6V motor with read/write erase head and 2 cassette tapes (no amplifier)	5.00
GB131	30 each 6" shrink tubing, asst. sizes and colors	4.00
GB137	50 each Chokes, coils and inductors (molded-wire-adjustable)	3.00
GB138	2 each Speakers, 2¼", 8 ohm, 1/4 watt	1.95
GB155	300 each mixed resistors, capacitors diodes, transistors, chokes	3.00
GB160	Printed Circuit Board Contains 50-75 components on each board	2.00
GB163	30 ea. Sockets (Asst. IC and transistor)	4.00
GB177	200 each 1" Shrink tubing, asst. colors and sizes	3.00

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6% Sales Tax
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BOOKS

National Semiconductor — Intersil — Intel

30001	National CMOS Data Book (640 pages) 74C, CD4000, and A/D Converters	$5.95
30002	National Interface Data Book (704 pages) DP, DS8000, DS3600, DS75000, etc.	$5.95
30003	National Linear Data Book (1376 pages) LM, LF, ADC, DAC, LH Series	$8.95
30004	National Series 80 — Board Level Computer (224 pages)	$4.95
30005	National TTL Logic Data Book (624 pages) 7400, LS, L, H, S, and DM8000 Series	$8.95
30006	Buy above (3) 30001,3,5 as a set	$19.95/lot
30009	Intersil Data Book (1074 pages)	$6.95
010400	Intel Component Data Catalog — Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	$10.00
205610	Intel Peripheral Design Handbook — Full data sheets, appl. notes for Intel peripheral device components (644 pages)	$7.50

AC and DC Wall Transformers



With Universal Plug and 9V Battery Snap

Selective voltages: 6,9,12VDC. Polarity selection (+/-). six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz. 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
DC 800	120V/60Hz	8VDC 400mA (batt. charger)	$2.49
DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	$9.95
DV9200	117V/60Hz	9VDC 200mA	$3.25
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$3.95

CONNECTORS



DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	ScrewLock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K
Kit comes complete with:

- 8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)
- Documentation for conversion

TRS-16K2 *150ns	19.95
TRS-16K3 *200ns	16.95
TRS-16K4 *250ns	14.95

KEYBOARDS

Limited Quantity



Datanectics 74-Key Keyboard

Uses EA 20134 Chip (Electronic Arrays). Size: 16¾"L x 5½"W x 1-3/8"H. White, black, blue, grey key caps. (No Data Sheet) —

Part No. KB354 .... $29.95 ea.



Micro Switch 69-Key Keyboard

Uses AMI SW20350K Chip. Size: 16-3/8"L x 5¼"W x 1-5/8"H Metal Frame. Light & dark grey key caps (No Data Sheet)

Part No. KB69SD12-2 .... $19.95 ea.

Boschert Multi-Voltage Power Supply

5VDC, 12VDC and 24VDC

Limited Quantity



FEATURES: Voltages*: 5VDC @ 25amps, 12VDC @ 4amps, & 24VDC @ 4amps. Reg. Load: +5V out ±1%, +12 & 24V out ±5% (20-100% load). Overvolt. & overcurr. protection. 115 or 230VAC Input. Wt. 4 lbs. Size: 4.95" x 2.50" x 15.00"
*Total average output shall not exceed 200 watts.

General Description: The "Boschert" Power Supply was originally designed for application with ITT Advance Terminal Controller (ATC). This open frame switching power supply provides user with high current requirements common in use with computer systems. Its compact size provides versatility for mounting into electronic enclosures. Each supply has 6 threaded fasteners (pem nut type) for mounting. Specification requirements to be used with ATC enclosed.

Part No. 200-3010 .... $69.95 each

— MANY OTHERS AVAILABLE • WRITE FOR INFORMATION —

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK	(After assembled as pictured above)	**$99.95**
JE600 Kit	19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) ..	**$59.95**
K19	19-Key Keyboard (Keyboard only)	**$14.95**
DTE-HK	(case only — 3½"Hx8¼"Wx8¾"D)	**$44.95**

Circle 224 on Inquiry card.

7400

Part	Price	Part	Price	Part	Price
SN7400N	.20	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

Part	Price	Part	Price	Part	Price
74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.59	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
74LS38	.39	74LS158	.89	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.15	74LS365	.69
74LS51	.35	74LS165	1.15	74LS366	.69
74LS54	.35	74LS168	1.19	74LS367	.69
74LS55	.35	74LS169	1.19	74LS368	.69
74LS73	.45	74LS170	1.95	74LS373	1.95
74LS74	.45	74LS173	.99	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.49			81LS95	1.95
74LS90	.69			81LS97	1.95

74S

Part	Price	Part	Price	Part	Price
74S00	.45	74S124	3.95	74S243	3.25
74S02	.45	74S133	.55	74S244	3.25
74S03	.45	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.45	74S140	.79	74S280	2.95
74S11	.45	74S151	1.35	74S287	3.25
74S15	.45	74S153	1.35	74S288	2.75
74S20	.45	74S157	1.35	74S373	3.49
74S22	.45	74S158	1.35	74S374	3.49
74S30	.45	74S160	2.95	74S387	2.95
74S32	.55	74S174	1.59	74S471	10.95
74S38	1.25	74S175	1.59	74S472	10.95
74S40	.50	74S188	2.95	74S473	10.95
74S51	.45	74S194	1.95	74S474	12.95
74S64	.50	74S195	1.95	74S475	12.95
74S65	.50	74S196	1.95	74S570	5.95
74S74	.75	74S240	2.95	74S571	5.95
74S86	.79	74S241	2.95	74S572	9.95
74S112	.79	74S242	3.25	74S573	9.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

CA—LINEAR

Part	Price	Part	Price	Part	Price
CA3010H	.99	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.49	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD—CMOS

Part	Price	Part	Price	Part	Price
CD4000	.39	CD4041	1.49	CD 4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	17.95
CD4028	.89	CD4078	.55	MC14410	18.95
CD4029	1.49	CD4081	.39	MC14411	15.95
CD4030	.49	CD4082	.39	MC14412	15.95
CD4034	3.49	CD4093	.99	MC14419	7.95
CD4035	.99			MC14433	15.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

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ONE YEAR FACTORY WARRANTY



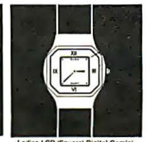
Ladies LCD (Round) Digital Gemini Gold with Leather Strap. 82395-5Y . . Sugg. Retail $140.00



Ladies LCD (Square) Digital Gemini · Silver with Silver Mesh Metal Strap 80396-5W . . Sugg. Retail $150.00



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LITRONIX Stick Display Sale

WHILE THEY LAST! — SALE!

MULTI DIGIT REFLECTOR ARRAYS FOR CLOCKS

PART NUMBER/COLOR	CHAR HT (IN.)	POLARITY	DESCRIPTION SEGMENT/DIGIT	OVERALL SIZE Length x Height x Depth	LIGHT OUTPUT (MCD) TYP	MIN	@mA	FORWARD VOLTAGE SEGMENT (V) I_F = 20mA TYP	MAX	CONTINUOUS FORWARD CURRENT PER SEGMENT (mA) MAX	PRICE	2 FOR SALE
DL-4500 (Red)	.50	C.C. MPX	With Colon and Auxiliary Indicators	3-3/16"x1-1/4"x5/16"	.8	.5	10	1.7	2.0	30	1.95	2/2.95
DL-4507 (Red)				3-3/16"x1"x5/16"	—	1.0					1.78	2/2.95
DLG-4507 (Grn)		C.C.		3-3/16"x1"x5/16"	.8	.5					4.95	2/7.95
DL-4520A (Red)		non-MPX		3-3/16"x1"x5/16"							2.49	2/2.95

MULTI-DIGIT REFLECTOR ARRAYS

PART NUMBER/COLOR	CHAR HT (IN.)	POLARITY	DESCRIPTION SEGMENT/DIGIT	OVERALL SIZE	TYP	MIN	@mA	TYP	MAX	CURRENT MAX	PRICE	2 FOR SALE
DL-2300 (Red)	.30	C.C. MPX	7 Seg. 2-Digit RHDP	11/16" x 7/8" x 1/4"	2.5	1.1	20	1.7	2.0	30	.79	2/.99
DLG-[illegible] (Grn)	[illegible]	C.A. MPX	9 Seg. 2 Digit	1-5/16"x1-1/2"x5/16"		2.5	20		3.5	25	.89	2/1.19
DL-4509 (Red)	.50	C.C. MPX	9 Seg. 4 Digit RHDP	2" x 1-5/16" x 5/16"	.8	.5	10	1.7	2.0	30	1.49	2/1.95
DL-3130 (Red)	1.0	C.A. MPX	7 Seg. 3 Digit RHDP	2-3/4"x1-11/16"x5/16"	1.5	1.0	10	3.4	4.0	30	2.25	2/3.49

NATIONAL Stick Display Sale

LIMITED QUANTITY! — SALE!

LED NUMERIC ARRAYS

PART NO.	DIGIT SIZE (RED)	FORMAT	DRIVE Comm. Cathode/Comm. Anode	OVERALL SIZE	PRICE	SALE
NSA166	.100 (9 Bubble Stick)	888888	C.C. 6 Digit Multiplexed	2"L x .72"H x .27"D	$ .50	2/.99
NSA198	.100 (9 Bubble Stick)	8.8.8.8.8.8.8.8.8.	C.C. 9 Digit Multiplexed	2"L x .72"H x .27"D	.60	2/.99
NSA298	.100 (9 Bubble Stick)	8.8.8.8.8.8.8.8.8.	C.C. 9 Digit Multiplexed	1.98"L x .72"H x .27"D	.60	2/.99
NSA1140	.100 (9 Bubble Stick)	88 : 88	C.C. 4 Digit Multiplexed	2"L x .72"H x .27"D	.49	2/.79
NSA1150	.100 (9 Bubble Stick)	8 88 : 88	C.C. 5 Digit Multiplexed	2"L x .72"H x .27"D	.49	2/.59
NSA1588	.140 (9 Bubble Stick)	88888888	C.C. 8 Digit Multiplexed	2-3/8"L x .72"H x .27"D	.69	2/1.19

MULTI-DIGIT LED NUMERIC DISPLAYS

PART NO.	DIGIT SIZE (RED)	FORMAT	DRIVE	OVERALL SIZE	PRICE	SALE
NSN373	.3 No Decimal	88	C.C. 2 Digit Direct	.80"L x .80"H x .225"D	$ .69	2/.79
NSN374	.3 No Decimal	88	C.A. 2 Digit Direct	.80"L x .80"H x .225"D	.79	2/.99
NSN501	.5 No Decimal	88	C.A. 2 Digit Direct	1.40"L x 1.14"H x .32"D (7/16" pins)	.89	2/1.49
NSN502	.5 No Decimal	88	C.A. 2 Digit Direct	1.40"L x 1.14"H x .32"D (7/16" pins)	.89	2/1.49
NSN581	.5	88	C.C. 2 Digit Multiplexed	1"L x 1.05"H x .28"D (7/16" pins)	.99	2/1.79
NSN583	.5	88	C.C. 2 Digit Direct	1"L x 1.05"H x .28"D (5/8" pins)	.99	2/1.79
NSN781	.7	88	C.C. 2 Digit Multiplexed	1.2"L x 1.25"H x .3"D	1.19	2/1.95
NSB2100	.3	88✕88=8888	C.C. 8 Digit (10 Spaces)	4"L x .60"H x .250"D	.75	2/.89
NSB3001	.3	8888	C.C. 4 Digit Multiplexed	1.59"L x .85"H x .25"D (7/16" pins)	.75	2/.89
NSB3382	.3	+:888	C.A. 3½ Digit Multiplexed	1.60"L x .80"H x .225"D	.99	2/1.49
NSB3411	.3	PM 88 : 88	C.C. 4 Digit – Colon/PM Indicator	1-9/16"L x 13/16"H x 3/16"D	.99	2/1.19
NSB3652	.3	•:8 •88 88	C.C. 6 Digit – AM/PM, Failure Ind.	3"L x 1.10"H x 7/32"D	2.95	2/3.95
NSB3854	.3	88888888	C.A. 8 Digit Multiplexed	3"L x 1-3/32"H x 3/16"D	2.95	2/3.95
NSB3881*	.3	8.8.8.8.	C.C. 4 Digit Multiplexed	1.59"L x .80"H x .225"D	2.95	2/4.95
NSB3882*	.3	8.8.8.8.	C.A. 4 Digit Multiplexed	1.59"L x .80"H x .225"D	2.95	2/4.95
NSB5382*	.5	+:8.8.8.	C.A. 3½ Digit Multiplexed	1.99"L x 1.00"H x .28"D	3.49	2/5.95
NSB5441	.5	•88 : 88	C.C. 4 Digit – AM/PM, Colon Ind.	3.00"L x 1.10"H x .282"D	2.95	2/3.95
NSB5881*	.5	8888	C.C. 4 Digit Multiplexed	1.99"L x 1.00"H x .280"D	3.49	2/5.95
NSB5882*	.5	8888	C.A. 4 Digit Multiplexed	1.99"L x 1.00"H x .280"D	3.49	2/5.95
NSB5918	.5	+8888	C.C. 3¾ Digit Multiplexed	3.00"L x 1.10"H x .282"D	2.49	2/3.49
NSB5922	.5	88888	C.A. 5 Digit Multiplexed	3.00"L x 1.10"H x .282"D	2.95	2/3.49
NSB7923	.7	888888	C.C. 6 Digit Multiplexed	3.60"L x 1.35"H x .292"D (3/8" pins)	3.95	2/4.95

*Standard Stocked Items – only pin out specifications available on non-stocked items

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2,000	10	2.95	13,000	16	2.95	50,000	20	7.95
2,250	100	3.95	14,000	13	2.95	52,000	20	5.95
2,300	33	2.95	14,000	35	3.95	55,000	15	5.95
2,500	15	2.95	18,000	10	3.95	58,000	20	5.95
3,000	25	1.95	20,000	20	2.95	65,000	10	7.95
3,600	40	3.95	20,000	55	3.95	73,800	5	7.95
4,500	50	3.95	21,000	15	3.95	80,000	15	9.95
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16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
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16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

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14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
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INTERSIL

Part No.	Function	Price
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7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLO.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
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8069CCQ	50ppm Band—GAPVolt Ref. Diode	2.50
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74C

Part	Price	Part	Price	Part	Price
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74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

Part	Price	Part	Price	Part	Price
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LH0070-0H	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
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LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
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LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
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LM309K	1.25	LM377N	2.95	LM1800N	2.95
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LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
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LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
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LM324N	.99	NE536H	6.00	LM3916N	3.95
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LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

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22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

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.0022mf	.12	.10	.07	.047mf	.21	.17	.13
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.01mf	.12	.10	.07	.22mf	.33	.27	.22

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.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

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1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

Circle 224 on inquiry card.

Unclassified Ads

FOR SALE: Synertek SYM-1 with 4 K monitor ROM and 1 K RAM. Excellent condition, with all manuals. $150 plus postage. Robert Perlstein, 142 Dumas Rd., Cherry Hill, NJ 08003, (609) 428-7282.

WANTED: Used computer-science books. Reasonably priced, in good condition for personal use—only one copy of a title wanted. Examples: programming languages, Knuth (Vol. 2), programming techniques, compiler design, applications, etc. M. Berman, Mathematics Dept., Room GT-113, Bronx Community College, Bronx, NY 10453.

FOR SALE: Programmer's Toolkit (3.0) for PET (8/16/32 K) and Commodore WP2 (16/32 K) and Temple of Apshai programs (32 K). Originally $170. Asking $70 for total package. MTU 8-bit D/A converter for PET. $35 or best offer. Philip Chao, POB 387, Rochester, NY 14642, (716) 442-0903.

FOR SALE: 32 K Sorcerer with Vista V200 5-inch dual disks, S-100 expansion box, music DAC, and video CRT. CP/M, Z80 assembler, BASIC and Development ROM PACs, and some Adventure games. Cost me $2800; will sell for $1600. Drop a card with quote and I'll call you. Gerald Owens, c/o S.M.C., Collegedale, TN 37315, (615) 396-3524 after 9 p.m.

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FOR SALE: National Semiconductor Digitalker DT-1050 3-chip set. Never used, still in box. $40. Jeffrey M. Craig, 3001 South King Dr. Apt. 912, Chicago, IL 60616.

FOR SALE: Jade double-density disk controller. S-100 bus compatible. Reads and writes single- or double-density, 5- or 8-inch, single- or double-sided. Uses on-board Z80A. Has serial printer port. $200. Jim Burrett, 5-629 Rubdige St., Peterborough, Ontario, Canada, (705) 742-4831.

FOR SALE OR TRADE: Assembled and tested Disk-80 (BYTE, March 1981) substitute for RS expansion interface. Originally cost $429.95. Two months old. For sale at $250 or trade for database/business programs, printers, or hardware. Includes: 32 K RAM, disk controller for four drives, real-time clock, printer port, power supply, cable to TRS-80, case, and documentation. A. Keung, 761 Fieldstone Rd., Mississauga, Ontario, L5C 3K7 Canada, (416) 279-4613 after 6 p.m.

WANTED: Manuals covering the electronic portions of the Savin 900 Wordmaster and the Holmes Tycom KSR38 Selectric typewriter modification. I have the baseplate information available, if anyone needs it, but need maintenance manual or at least schematic for the digital electronics parts of both units, particularly the circuit boards of the Savin 900. Will pay for originals or copies. Please call collect. Bob Howard, 1234 South First Ave., Arcadia, CA 91006, (213) 446-3302.

FOR SALE: OSI C1P Challenger with 32 K memory, mini-disk drive with DOS, APF 9-inch monitor, manuals, and repair manual. Barry Hammer, (608) 725-5114.

WANTED: The following back issues of Microsystems: 1-1, 1-3, 1-6, and 2-2. DJC, POB 4163, Spartanburg, SC 29303, (803) 583-6106.

FOR SALE: IEEE Computer, 35 issues from 9/71 to 2/78 (some missing). Communications of the ACM, Vol. 23: #3, 5, 6, 9, 11 and Vol. 24: #1, 3. 73. 2/76 to 4/76. IEEE Spectrum, 89 issues from 2/68 to 2/76 (some missing). Everything for $150 or best offer. You pay postage. David Wolverton, 301 C Nubes, Irvine, CA 92715, (714) 752-7303.

FOR SALE: Tektronix 4051 graphics computer system. Includes 4662 digital plotter, 4924 tape drive, 4952 joystick, data-communications interface, Extended BASIC, editor, binary loader, ROM pack expander, manuals, and more. Software included: Mathematics Vol. 1 & 2, Stat Vol. 1-4, Mangmt Vol. 1 & 2, Plotter, and Graphics programs. More than 30 tapes. Can be used as stand-alone or terminal. Present price is over $20,000, but will sell for $5000. Ron Bremer, 19645 Southwest Wright St., Aloha, OR 97007, (503) 642-1048, 629-1859.

First Place Tie

The February BOMB results ended in a tie for first place between Steve Ciarcia for "Build a Computerized Weather Station" and Steve Leibson for "The Input/Output Primer, Part 1: What is I/O?" Each will receive $100. Neal Atkins and Enrique Castro-Cid captured the second-place prize of $50 for their description of "A Homebrew Graphics Digitizer." Our readers evidently appreciated the tax advice offered by Melvyn Feuerman and Melvyn Moller as their article "Tax Tips for Computer Owners" placed third. Our congratulations to these authors.

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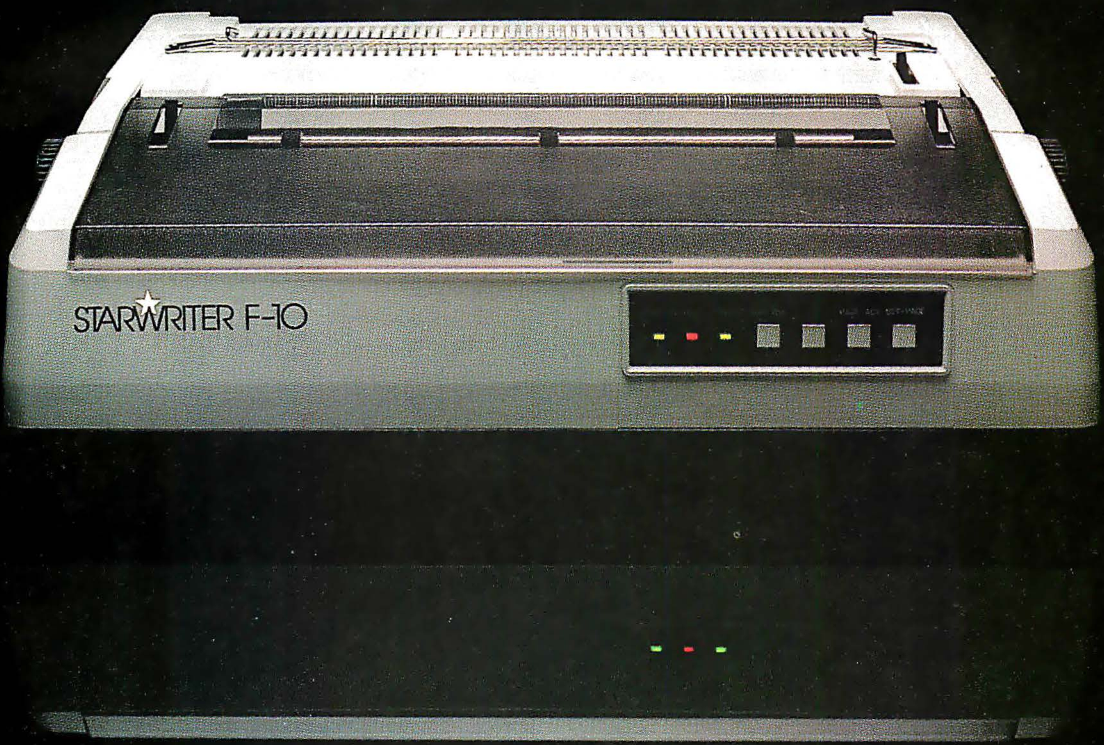
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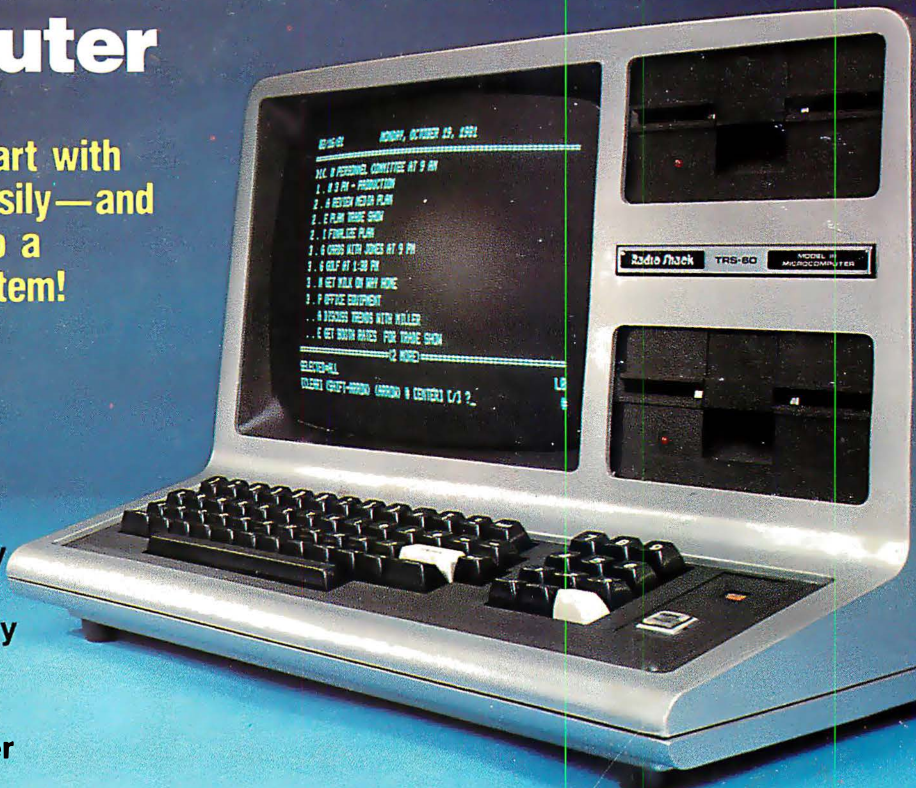
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